THE RELATIONSHIP OF MEALTIME COMMUNICATION AND ORAL-MOTOR FEEDING SKILLS TO LATER LANGUAGE SKILLS IN PREMATURE INFANTS

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ABSTRACT

CARA MCCOMISH: The Relationship of Mealtime Communication and Oral-Motor Feeding Skills to Later Language Skills in Premature Infants
(Under the direction of Elizabeth Crais, Ph.D.)

Both clinical and theoretical assumptions exist across disciplines which suggest that early feeding skills may be precursors to later speech and language skills. An additional question that has remained unclear is whether an altered trajectory of early feeding and oral motor skills development sets an infant on a path for altered or disordered speech and language development. The literature is also unclear in determining if there is a link between early feeding communicative behaviors and later speech and language skills. In order to better understand these relationships the current study examined infant communication during feeding and nonfeeding interactions and oral-motor feeding skills at 6 months adjusted age and later language scores at 2 years of age in 42 premature African American infants. In addition, data for variables that put premature infants “at risk” for developmental delays as documented prior to discharge, as well as maternal responsiveness at 6 months adjusted age were explored for relationships between these “at risk” variables and later infant language scores.

The results of the study revealed a significant predictive relationship between mealtime communication “red flags” at 6 months adjusted age and language scores on the Preschool Language Scale-4 (Zimmerman, Steiner, & Pond, 2002) at 2 years of age. Analyses also identified a significant predictive relationship between mothers’ global

level of responsiveness during feeding and nonfeeding interactions and infant language scores at 2 years of age. Additionally, variables that put premature infants “at risk” for developmental delays as documented prior to hospital discharge were also found to be predictive of later language scores. These findings emphasize the potential importance of observing mealtime communication during interactions between African American premature infants and their caregivers. In addition, these findings document the need for further research on the oral-motor feeding problems that may be unique to formerly premature infants. Further, the current investigation reveals the value in examining premature infants’ early communication development within the context of their family systems and interactions with caregivers.

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TABLE OF CONTENTS

LIST OF TABLES

Table

LIST OF FIGURES

Figure

CHAPTER 1

STATEMENT OF THE PROBLEM

Both clinical and theoretical assumptions exist across disciplines which suggest that early feeding skills may be precursors to later speech and language skills (Gisel & Pollock, 1988; Morris, 1981; Morris & Klein, 2000; Stroh, Robinson, & Stroh, 1986; Treharne, 1980). For example, in the 1987 edition of Morris and Klein's much referenced clinical manual, "Pre-Feeding Skills", the relationship between feeding and speech is discussed; yet 13 years later in the second edition of this text (Morris & Klein, 2000), this relationship is still introduced as an ongoing question in our field with regard to whether there is a causal relationship between the motor control used for nonspeech-oral movements such as feeding and that used for speech production. The authors cite research literature that suggests two control systems are responsible for a separate development of these skills, (Green, Moore, Higashikawa, & Steeve, 2000; Moore & Ruark, 1996; Ruark & Moore, 1997); as well as research that suggests that the two systems are closely related or operate in a causal fashion (Love, Hagerman, & Taimi, 1980; Marshalla, 1985). Morris & Klein (2000) come to a middle ground in this debate by stating that "there is a strong possibility that feeding and speech control systems are related at least during the first year" (p. 534), suggesting that early dysfunctional or disorganized patterns of feeding and communication skills may set a foundation that could place the infant on an altered trajectory for later development. An additional question that has remained unclear is whether an altered trajectory of early feeding and oral motor skills development sets an infant on a path for altered or disordered speech and language development. The literature is also unclear in determining if there is a link between early feeding communicative behaviors and later speech and language skills. Due to the fact that feeding interactions occur multiple times a day in natural contexts and environments, such information could theoretically drive both feeding and communication interventions with infants and their families.

Research aimed at delineating these relationships has focused on "at risk" populations. Premature infants represent one group "at risk" in the area of feeding skills development. Many premature infants face early feeding difficulties and continued feeding problems (Hawdon, Beauregard, Slattery, & Kennedy, 2000). In addition, many premature infants are also "at risk" for later speech and language delays (Mathisen, Worrall, O'Callaghan, Wall, & Shepard, 2000). However, only rarely are continued feeding problems (after discharge from the NICU to home) or communication difficulties identified in the first year of life. Most NICU follow-up of high risk infants is hospital specific and not consistent among hospitals. Since most hospital based developmental surveillance clinics are found in larger metropolitan areas, they are often far from the preterm infant's community (Jackson & Needelman, 2007), making access to these services more difficult for rural families of lower socioeconomic status for whom transportation may be a barrier to accessing services.

While premature infants represent over 12% of live births in the United States each year, the federal government reports that as of 2003 only 1% of all infants under one year of age had received early intervention services, while only 2.1% of 1 year olds and 3.6% of 2 year olds had been enrolled in early intervention (Martin, Hamilton, & Sutton, 2005).

Children referred to Early Intervention (EI) supports and services in the United States enter at an average age of 15.7 months, although parents usually began voicing concerns by 7.4 months (Bailey, Hebbeler, Scarborough, Spiker, & Mallik, 2004). These statistics represent very low overall figures for identifying children at risk for deficits within the general population in the first years of life, and represent only the children actually referred to Birth to Three services. There is a general lack of early identification of children at risk for developmental disabilities within the overall population. Identifying those premature infants most in need of early intervention supports and services presents another challenge to the Early Intervention system.

Theoretical Bases for the Study of Communication in the Context of Feeding

Researchers have come to recognize that the development of language as a symbolic system cannot exist apart from social interactions (Lewis & Freedle, 1973). Over the last four decades research has consistently shown that communication skill develops within the context of social interactions, in natural environments, and over time (Bruner, 1981; Chapman, 2000; Hsu & Fogel, 2003; Lewis & Freedle, 1973; Sameroff, 1975; Sameroff & Mackenzie, 2003). The interactions of the infant and caregiver are now viewed as a finely tuned and mutually co-regulated system wherein each participant acts in a reciprocal manner (Fogel, 1993). One early and frequently occurring context for these reciprocal processes is the feeding interaction, a normal process essential to the life and development of the newborn infant. Feeding is also the initial activity in which young children interact with others and with their environments. Feeding interactions represent a social interaction that occurs many times a day over the first days, weeks, and months of an infant's life. For feeding to be successful both members of the feeding dyad must communicate and be responsive to cues of engagement and readiness.

Communication Development

It is commonly accepted that communication begins well before the onset of speech, and that communication development occurs within the context of social interactions. Communication between infants and their caregivers begins at birth and becomes increasingly complex as the infant grows and develops (Skinner et al., 1998). Communication, like feeding, is a reciprocal process that depends on both the abilities and the characteristics of the infant and the caregiver; and in both areas contingency and responsiveness are important (Crais, 1999). As infants enter the second half of the first year of life the time period between 6-8 months of age becomes a dynamic time for the development of communication. During these months most infants begin to develop an understanding of language, and begin to use non-verbal communication such as eye gaze, reaching, and pre-gestural communicative acts such as protesting behaviors (Crais, Douglas, & Campbell, 2004; Oller, Eilers, Neal, & Schwartz, 1999). Additionally, the emergence of expressive or pre-speech and early speech sounds (e.g. pre-canonical and canonical or reduplicated babbling sounds) may be observable at this time (Davis & MacNeilage, 1995). In fact, researchers who have studied the prediction of later communication delays in full term otherwise healthy infants and young children have documented that an absence or reduction in early gesture and/or early vocalizations such as babbling are significant predictors of later communication delays or disorders (Oller et al., 1999; Thal & Tobias, 1992, 1994).

Feeding Development

Feeding interactions begin to occur almost immediately after birth, and are one of the most frequently occurring interactions between infant and caregiver during the first year of life. Feeding can be defined as the initial stage of eating during which a caregiver presents nutritive products to a child for ingestion (Sparling & Rogers, 1985). Effective feeding requires a give and take exchange between caregiver and child with the behavior of each dependent on the other (Satter, 2000). Although eating is regarded as a basic function, it is in fact a complex motor task that requires oral motor skills for sucking and bolus formation to be coordinated with breathing and swallowing. These actions require both the neurological maturation to control and adjust the intricate movements of physical structures and muscles, and the synchronization of timing and rhythmicity in the suck, swallow, and respiratory functions (Gewolb, Bosma, Reynolds, & Vice, 2003). Eating is also a social task, which involves the mutual timing of caregiver and infant in reciprocal interactions and reading cues. For most healthy, full term infants this coordination and the subsequent feeding interactions that occur between caregiver and child appear to be effortless. Therefore, feeding and swallowing represent the first “window” through which caregivers can view and assess the overall health and neurodevelopmental well-being of infants (Rogers & Arvedson, 2005).

During the first four to six months of life multiple occurrences of feeding interactions take place between caregivers and infants within the context of breast and/or bottle feeding. Some infants initially struggle with the coordination of sucking, swallowing, and breathing requirements for these tasks. By the age of 4-6 months these early struggles may decrease for some infants while others may continue to struggle into the transition to solid foods. Conversely, infants who did not struggle with breast or bottle feeding may begin to experience difficulties as caregivers introduce new textures and tastes. Infants who are ready for the introduction of solid foods will begin to show signs of physiological readiness (e.g. sitting upright in supported or partially supported positions) at around 4-6 months of age. This stage represents a time in the development of feeding skills that may involve a period of relative stability for many infants. However, this is also a time of great change in both the growth of facial and oral structures used for feeding and speech. During the second six months feeding continues to be the focus of a large percentage of the time that infants and caregivers spend together (Satter, 1999). Therefore, the age of approximately 6 months represents a point in time in which observation of feeding skills should be marked by relative physiological stability (e.g. stable respiratory status) with increased demands on the infant as more mature oral-motor feeding patterns are required for consuming solids and semi-solids.

The Relationship of Feeding and Communication Development

Feeding and communication are linked in many ways throughout infancy and early childhood (Crais, 1999). Feeding interactions occur between caregivers and infants multiple times each day, and provide many of the earliest contexts for social communication (Satter, 2000). During feeding interactions throughout the 2 to 24 month period research shows that most infants are communicating via behaviors such as facial expressions, body movements, and later gestures (Mason, Harris, & Blissett, 2005; Skinner et al., 1998). The transactional "conversations" that take place during feeding interactions demonstrate the reciprocal give and take of this relationship; mother and child are mutually engaged and are both co-regulating the experience (Fogel, 1993).

Populations At Risk for Feeding and Communication Deficits

Early feeding dysfunction is often considered to be an early indicator of possible neurological problems, which may result in future diagnoses of language or developmental delays (Hawdon et al., 2000; Selley et al., 2001). As stated earlier, premature infants represent one group "at risk" in the areas of feeding and speech and language development. Preterm infants are those born at less than 37 completed weeks of gestation; these infants comprise approximately 12.7% of annual live births in the U.S. (Martin et al., 2005). The World Health Organization classifies the 85% of all the births that take place between 31 and 37 weeks gestation as "premature", with 10% of preterm infants born between 28 and 31 weeks as "very premature", and the remaining 5% of preterm infants that are born before 28 weeks gestation as being "extremely premature" (Moutquin, 2003). Very low birth weight (VLBW) infants are those born at less than 1500 grams, and approximately 50% of preterm infants who require mechanical ventilation or weigh less than 1500 grams at birth will present with health and at least mild developmental delays and/or learning disabilities including communication disorders by school age (Bhutta, Cleves, Casey, Cradock, & Anand, 2002; van Kessel-Feddema, Sondaar, de Kleine, Verhaak, & van Bar, 2007). Many VLBW premature infants exhibit early feeding difficulties, and have been found to be at risk for continued and persistent feeding problems (Hawdon et al., 2000), as well as later speech and language delays (Aram, Hack, Hawkins, Weissman, & Borawski-Clark, 1991; Mathisen et al., 2000).

While feeding interactions are usually seamless and smooth in dyads involving full term infants and their caregivers, premature infants and their caregivers often struggle early on to communicate during feeding interactions, as the cues of a preterm infant may be less obvious or easy to read for the caregiver (Barratt, Roach, & Leavitt, 1992; Muller-Nix et al., 2004; Thoyre & Brown, 2004). In preterm infants physiological problems which impact early feeding interactions could set up communicative patterns between infants and caregivers that are not the most conducive to facilitating language development. Effects of feeding problems could cascade developmentally, even if the physiological aspects of feeding difficulty resolve, thus setting the infant on an altered path with regard to communication development. Therefore, early feeding struggles could be "red flags" indicative of future developmental problems that could require ongoing supports and services for the child and his or her family.

This study examined early communication, and specifically, mealtime communication, as well as oral-motor feeding skills in 6-month-old infants who were born prematurely, and investigated whether these skills predicted later speech and language development at 2 years of age. In addition, variables present at discharge and overall caregiver responsivity that may impact these later skills were examined. Based on the clinical and theoretical assumptions of a relationship between early feeding and communication skills and later speech and language, and the potential impact of early risk factors including maternal responsivity, it is imperative that research be conducted to document whether a predictive relationship exists.

Purpose Statement and Research Questions

The specific purpose of this study was to investigate whether oral-motor feeding skills and communicative behaviors observed during non-feeding and feeding interactions between premature infants at 6 months adjusted age and their caregivers were predictive of later speech and language and cognitive abilities as measured by standardized assessments at 24 months of age. A dynamic systems framework was used to address these questions in addition to the examination of variables that could increase the infants' "at risk" status prior to discharge from the hospital, as well the caregiver's global level of contingent responsiveness during both feeding and nonfeeding interactions at 6 months adjusted age.

"Red flags" of infant oral-motor feeding dysfunction during mealtimes and "red flags" of possible communication delays were identified and coded during overall interactions between infants and their caregivers, as well as specifically during mealtime interactions at 6 months adjusted age. In addition, information obtained prior to infant discharge from the hospital that is typically used to predict developmental outcomes included Neurobiological Risk Scores or NBRS (Brazy, Goldstein, Oehler, Gustafason, & Thompson, 1993), gestational age, birthweight, and length of time in days of mechanical ventilation and total hospital stay. These data were used in the current study to determine whether such variables could predict later language outcomes in this group of premature infants.

The investigation provides some initial information with regard to the feeding and communicative development of these premature infants as it relates to later speech and language skills. Having an increased understanding of the specific oral-motor feeding skills and mealtime communicative acts of preterm infants at 6 months corrected age that are predictive of speech and language skills at 24 months of age could enable professionals to partner with families in the future in early interventions for feeding difficulties and early language difficulties. Additionally, information on risk variables prior to discharge and the predictive value of caregiver contingent responsivity may guide in the decision making process for intervention planning. The research questions were therefore as follows:

1. Do early communicative behaviors at 6 months of age in preterm infants predict later speech and language skills as demonstrated on the scores of the *Preschool Language Scale-4* (PLS-4) (Zimmerman et al., 2002), as well as later cognitive scores that encompass language on the *Bayley Scales of Infant Development-II* (Bayley, 1993) at 2 years of age? It was expected that the amount and type of infant communicative behavioral acts during feeding and non-feeding interactions at 6 months adjusted age would predict later speech and language skills in this sample of premature infants.
   - 1.A. What aspects of early communicative behaviors (e.g. vocalizing acts, early pre-gestural acts) at 6 months adjusted age had the greatest predictive value for later speech and language skills in preterm infants?
   - 1.B. What aspects of early communicative behaviors at 6 months adjusted age were the most predictive of Expressive Communication and Auditory Comprehension subscale scores on the PLS-4 (Zimmerman et al., 2002) at 2 years of age?
2. Do early oral-motor feeding skills at 6 months of age in preterm infants predict later speech and language skills as demonstrated on the PLS-4 at 2 years of age? It was hypothesized that early oral-motor feeding skills at 6 months of age in preterm infants would be predictive of later speech and language skills at 2 years of age. This hypothesis was based on the knowledge and clinical assumptions that the same oral structures used in feeding are used later in the production of speech, and that

perturbations in one system may impact the other system. There will be two additional levels to this question:

2.A. What aspects of early oral-motor feeding skills (such as rhythmicity of suck/swallow/breathe, lip seal, etc.) at 6 months in infants who were born prematurely were most predictive of later speech and language skills on the PLS-4 at 2 years of age?

2.B. What aspects of early oral-motor feeding skills at 6 months of age in infants who were born prematurely were most predictive of Expressive Communication and Auditory Comprehension subscale scores on the PL S-4?

3. When considering early communication development within a dynamic systems framework encompassing both infant and caregiver variables, do early influences prior to discharge from the hospital and caregiver responsivity at 6 months adjusted age predict later developmental outcomes in this group of rural African American premature infants?

3.A. Which early indicators of possible developmental delays as recorded prior to hospital discharge had predictive value for later language scores in this group of premature infants? Such indicators could include decreased gestational age or birthweight, increased Neurobiological Risk Scores or NBRS (Brazy et al, 1993), and increased days on mechanical ventilation and length of hospital stay in days. It was hypothesized that early influences (before discharge from the hospital and at 6 months adjusted age) would predict later developmental outcomes.

3.B. Does global level of caregiver responsiveness during both feeding and nonfeeding interactions at 6 months adjusted age predict infant language and cognitive scores at 2 years of age? The global level of caregiver contingent responsiveness during both feeding and nonfeeding interactions at 6 months adjusted age was also expected to predict both language and cognitive scores at 24 months of age.

CHAPTER 2

REVIEW OF THE LITERATURE

The review presented below summarizes the pertinent literature related to communication and feeding skills development, and applies the development in these areas to premature infants within a framework of a systems conceptual model. In doing so, current research examining the development of communication and feeding skills in typically developing full-term and premature infants is reviewed. In addition, due to the specific population selected for the study, potential factors that contribute to the development of communication and feeding skills in African American premature infants is discussed. A particular emphasis is placed on the role of feeding skills and communicative behavioral acts observed during mealtimes in infancy and their potential contributions to later language skills.

Communication Development

It is commonly accepted that communication begins well before the onset of speech, and that communication development occurs within the context of social interactions (Bruner, 1981). Communication between infants and their caregivers begins shortly after birth and becomes an increasingly complex and reciprocal process as the infant grows and develops (Skinner et al., 1998). Much of the first year of life in infancy is spent learning to become a communicator. In the first few weeks of life infants are especially responsive to their caregivers' faces and voices (Owens, Metz, & Haas, 2007). By 3 months of age many infants are able to respond vocally to a caregiver, and can visually differentiate familiar from unfamiliar faces (Fogel, 2001). Later in infancy, at approximately 7-8 months of age, many typically developing infants begin to gesture (Crais et al., 2004). The emergence of “intentional” communicative acts begins with the observation of gestures at around 7-8 months of age, when infants move from a perlocutionary stage of preintentional communication (adults attributing meaning to infant behaviors) to an illocutionary stage of intentional communication where infant behaviors are produced with the intent of conveying meaning to an interactive partner (Bates, 1976, 1979; Calandrella & Wilcox, 2000). While some researchers favor such a stage model approach to the development of intentionality, others discuss communicative intentionality within the context of a broader developmental continuum (Wetherby, Cain, Tonclas, & Walker, 1988).

Early infant communication includes behaviors such as looking at caregivers, vocalizing, and gesturing to initiate or engage the caregiver in social interactions or in response to caregiver communicative bids. As is highlighted throughout this literature review, children who demonstrate these early communicative skills (e.g. looking, gesturing, canonical babbling) are less at risk for later speech and language delays than those who do not exhibit these skills by the end of the first year of life. The following sections provide information on the developmental course of each of these communicative skills.

Eye Gaze, Looking, and Engagement- Emerging Intentionality

The first pre-language communicative behaviors include eye gaze (Stern, 1981), where the infant is believed to have mature voluntary control of gaze behaviors between 3 and 4 months of age (White, Castle, & Held, 1964). Although infants have control over their gaze behaviors at such an early point in development, research documents that the earliest age at which infants may be said to follow the general gaze direction of others is 8-10 months of age (Carpenter, Nagell, Tomasello, Butterworth, & Moore, 1998). The second stage, head orientation, is followed by later stages of use of upper or lower body orientation for spatial positioning. This period of infancy from birth to six months of age has been referred to as a time of "primary intersubjectivity", during which infants quickly become able to engage in person-to-person reciprocal interactions with caregivers. This stage in development is highlighted by the infant's transition from a "subjective" being, able to regulate his or her own body with self-awareness, to an emerging "intersubjective" being, able to engage in and mutually regulate interactions with others. Such person-to-person awareness involves mutual regulation of caregiver, as well as infant interests and feelings. This has been documented in research with infants as young as 2 months of age when they are looking at and listening to their mothers (Trevarthen & Aitken, 2001). Dyadic interactions may include transactional turn taking or imitation games that require mutual engagement and cooperative awareness of both participants. Observable behaviors in such interactions which may demonstrate the infant's "primary intersubjectivity" include: proto-conversational vocal play with turn-taking, eye contact, imitation of facial expressions or body rhythmical movements, emotion perception and responses, and social smile (Beebe, Rustin, Sorter, & Knoblauch, 2003). Mothers and fathers both have been documented to behave with intense responsiveness and expression, and these stimulating behaviors absorb the attention of the infant and result in intricate, co-regulated interchanges with turns of displaying and attending. Co-regulation takes place when caregiver and infant actions blend together to achieve a unique and mutually created set of social exchanges (Fogel, 1993). "Secondary intersubjectivity" typically emerges around 8-12 months of age, and involves a period of emergence into a person-person-object awareness (Trevarthen & Aitken, 2001). At this stage in development infants have increasing interest and ability to manipulate objects. These actions motivate the child to engage in more lively and elaborate exchanges with a caregiver and objects. This social coordination is a major stepping stone on the road to language acquisition; being aware that attention on some external thing is shared allows for a new understanding with regard to attention and following cues in triadic interactions (Baldwin, 1995). Prior to this point infants can be said to be emerging into intentional communication and infant-initiated social interactions. Therefore, the age of 6 months adjusted age in chronologically older (7 to 9 months chronological age) premature infants may provide a window of time to observe these emerging intentional communicative behavioral acts. As Carpenter et al (1998) concluded, "infants major social-cognitive skills all emerge largely within the age period between 9 to 15 months…infants begin participating in episodes of joint attentional engagement with adults at around 9 months of age" (p. 23).

Communicative Behavioral Acts- Early Gestures

Gestures are one of the most consistent early indicators of intentionality (Carpenter, Mastergeorge, & Coggins, 1983; Crais et al., 2004) and are defined as "actions produced with the intent to communicate typically expressed using the fingers, hands, arms, facial features and body motions" (Iverson & Thal, 1998). To determine whether a behavior can be considered a *communicative gestural act*, Wetherby and Prizant (1993) developed a checklist modified from Bruner's gesture definitions (1981).

This checklist has been further modified and used in other research to provide guidelines for defining early gestures (Colgan et al., 2006). In summary, to be considered a gesture, the communicative act must be described by answering “yes” to each of the following three criteria: 1. observation of giving, pushing, pointing, open handed reaching, or showing behaviors; or documentation of one of the following common gestures: shaking or nodding head, clapping hands, waving bye, dancing (to music/singing), blowing a kiss; 2. the act was directed toward another person with the infant either looking, vocalizing, touching, persisting, or sharing context with contingent response from caregiver; and 3. the act served a communicative function such as regulating another person’s behavior (behavior regulation), attracting another person’s attention to self (social interaction), or directing another person’s attention to an object or event (joint attention) (Bruner, 1981).

Iverson and Thal (1998) further defined two broad categories of gestures, deictic and representational. *Deictic gestures* are the earliest observable gestures, and include only those gestures that can be interpreted by their context, and are used to establish reference by calling attention to an object or event (Bates, 1976, 1979). Deictic gestures can be further broken down into contact (requiring contact between a child and object or caregiver, such as when infant pushes away a bottle or caregiver’s hand) and distal (gestures which require no contact between child and object or caregiver, such as pointing, which emerge around 11months). Reports in the literature of the earliest age to observe deictic gestures are somewhat different based on setting in which the observation took place (clinical environment vs. infant home) and methodology (caregiver report vs. direct observation); however, there is agreement that the range of ages to first observe these early gestures is approximately 7-9 months of age (Carpenter et al., 1998; Crais et al., 2004). Crais et al. (2004) found that the earliest emerging deictic gestures were protest behaviors (e.g. to indicate refusal, such as by pushing away), open-handed reaching (e.g. reaching to be picked up), and seeking attention gestures. Research shows that deictic gestures appear to account for approximately 88% of all gesture use in infancy (Thal & Tobias, 1992).

Representational gestures appear later in infancy, usually around 10 to 12 months of age, and after the establishment of a gestural repertoire that includes a number of the earlier appearing, deictic gestures (Crais et al., 2004). According to Iverson and Thal (1998), representational gestures include conventional gestures (e.g. representations of an action or concept such as waving "bye-bye"), as well as object related or "symbolic" gestures (e.g. "sniffing" a flower). These later appearing gestures often emerge within the context of social games and routines (e.g. pat a cake, peekaboo) during interactions between infants and toddlers and their caregivers (Acredolo & Goodwyn, 1988; Caselli, 1990; Goodwyn & Acredolo, 1993; Iverson & Thal, 1998; Werner & Kaplan, 1963).

As increased interest in the development of gestures has led to continued and ongoing research, a solid literature base has been developed over the last twenty years, and the links between gesture development and other areas of growth in infancy have become evident. For example, the emergence and developmental progression of gestures has been found to be closely linked with development of other domains, including the areas of cognition and imitation (Bates, Thal, & Janowsky, 1992). Further, research across disciplines over the last two decades has also documented the significant relationship between gesture development and later language skills (Capirici, Iverson, Pizzuto, & Volterra, 1996; Carpenter et al., 1998; Iverson, Capirici, & Caselli, 1994; Thal

& Tobias, 1992, 1994; Thal, Tobias, & Morrison, 1991). As a result of these data which delineate a clear relationship between gesture development and later language skills, standardized assessment tools used with infants and young children to determine eligibility for early supports and services are beginning to use observation and/or parent report of early gestures in scoring. For example, the Preschool Language Scale-4 (PLS-4) (Zimmerman, Steiner, & Pond, 2002) is the most recent edition of a language test for infants and young children age birth to 7 years of age. The *PLS-4* assesses development in both receptive and expressive language through subtests of auditory comprehension and expressive communication. This language evaluation tool has an item at 6-8 months to document whether the infant "protests by gesturing or vocalizing", and notes gestures again at 9-11 months, "communicates nonverbally, using gestures and pushing and pulling behaviors" (Zimmerman et al., 2002). This information allows for clinical documentation of what research is showing thus far- that a lack of early gestures in infants and young children may be a "red flag" of later language delays and disorders. However, this cursory documentation of gesture use does not provide the benefits that a detailed gesture profile may with regard to further assessment and intervention planning. Literature that attempts to link research to practice by describing gesture types, summarizing gesture research to date, and providing examples of current assessment tools is becoming available for both researchers and clinicians. This literature is particularly valuable as it could assist clinicians and researchers in pinpointing behaviors and factors for early identification of children with disabilities through gesture profiling (Crais, Watson, & Baranek, in press). Methodologies that take into account observation and detailed coding of infant gestures in natural environments may be best practice for documentation of early gesture use in infants, especially those at high risk for later communication delays.

The Development of Infant Vocalizations

The literature shows that the development of gestures and vocal development in infants are highly correlated (Bates & Dick, 2002), and both types of early communication are predictive of later speech and language development. In addition, correlations have been found between early vocalizations and later speech and language skills in typically developing infants (Stoel-Gammon, 1998). Specifically, more consonant-vowel syllables in the prelinguistic period have been linked to better scores on later speech and language measures.

Many researchers recognize four stages of vocal development, and these stages have been described by Oller and others in numerous publications (Oller, Oller, & Badon, 2006; Oller, 2000; Oller et al., 1999; Stark, 1980; Stoel-Gammon, 1992) and include the following: the phonation stage, the primitive articulation stage, the expansion stage, and the canonical stage. The phonation stage occurs during the first two months of life; during this stage, infants produce reflexive vowel-like sounds, including crying and grunting. By two to three months of age a typically developing child enters the primitive articulation stage as evidenced by his/her ‘cooing or gooing.’ Cooing and gooing are more advanced than reflexive sound production because articulation occurs during the vocalization as the infant gains increasing voluntary control over the speech apparatus. Between three to eight months of age, a typically developing child can be expected to have the ability to produce full vowel-like sounds and consonants with a closed vocal tract. When paired together, these two activities are known as marginal babbling, which takes place during the expansion stage. The syllables produced during marginal babbling are considered rudimentary, because they lack adult-like timing characteristics in overall duration and in consonant-vowel transitions. Another similar stage of vocalizations within this context of marginal babbling is documented by some writers on early phonological development as “vocal play” (Peccei, 2006; Stark, 1980; Stoel-Gammon, 1992). Vocal play is usually observed between the ages of 4-7 months, and consists of long sequences of vowels and rudimentary syllables in which infants seem to be “testing their equipment”. The new features of these vocalizations include a wide range of intensity and fundamental frequency differences; often these strings of sounds with rises in pitch and loudness levels are heard when infants are excited or during play.

According to Oller, (Oller et al., 1999), the last and most advanced precursor to speech is known as the canonical stage, which consists of well formed canonical syllables and reduplicated sequences of sounds. Canonical babbling differs from marginal babbling by involving “rapid transition from vowel-like elements to consonant-like elements”. These rapid transitions between sounds produced with “adult like timing” are the hallmarks of canonical babbling. The production of canonical syllables begins to emerge between 4 and 10 months of age, with a median at 6 to 7 months, and most infants should be producing canonical babbling by 10 months of age (Oller, Eilers, Neal, & Cobo-Lewis, 1998). Even “at risk” infants, including those born prematurely and/or of lower socio-economic status (SES), show stable onset of canonical babbling by 10 months of age (Oller et al., 1999; Oller, Eilers, Steffens, Lynch, & Urbano, 1994). Oller states that “the appearance of canonical babbling in infancy is developmentally significant because well-formed syllables are the basic building blocks of spoken languages” (1998) and “when it begins, parents all over the world recognize that their infants are nearly ready to start talking…(they) immediately try to shape their infant’s vocalizations to word-like purposes” (Oller et al., 1999). Research specific to canonical babbling has shown that the absence or delay of canonical babble has been found to be a very important indicator and possible “red flag” of future speech disorders, particularly phonological disorders (Oller et al., 1998; Oller et al., 1999).

Caregiver and Environmental Contributions to Communication Development

The development of both nonverbal and verbal communication as discussed above does not occur in isolation, but in the context of daily social interactions with caregivers during the first year of life and beyond. Both caregiver and environmental contributions impact the development of communication skills in infants and toddlers, and there is considerable evidence that the quality of early mother-infant interactions influences children’s social and cognitive development (Fish, Stifter, & Belsky, 1993). In addition, caregiver responsiveness to infant behavior plays a major role in infant acquisition of communicative competence (Dunst, Wortman Lowe, & Bartholomew, 1989) and more responsive and positive early mother-child interaction has been related to children’s later cognitive competence, self-efficacy, and positive affect (Eshel, Daelmans, Cabral de Mello, & Martines, 2006). With regard specifically to speech and language skills, maternal responsiveness has been linked to children’s achievement of language milestones and later language development (Bornstein, Tamis-LeMonda, & Haynes, 1999; Tamis-LeMonda, Bornstein, & Baumwell, 2001). The following sections define and describe the concept of “contingent responsiveness”, and focus on these terms as they relate to interactions between African American caregivers and their infants.

Caregiver Contingent Responsiveness

One of the most important factors in children's early language learning is the responsiveness of caregivers to children's communication attempts (Brady, Marquis, Fleming, & McLean, 2004). Contingency refers to the responsiveness of the adult to the infant's behaviors; a contingent response is an appropriate response that immediately follows some infant action (e.g. maternal smile following an infant smile). When responses are contingent, infants tend to smile, coo, and look more at adults (Fogel, 2001). The term *contingent responsiveness* is defined by Dunst et al., (1989) as "a wide range of conditional behaviors that are displayed by caregivers where social responsiveness functions as a reinforcer to maintain or evoke further behavior from the child" (p. 179). The authors go on to state that there is a large and developing body of evidence that shows that contingent social responsiveness to infant and toddler behavior, especially during naturally occurring interactions, is a powerful influence on infant acquisition of communicative competencies.

Caregiver responsivity and amount of caregiver input has clearly been associated with the rate of language acquisition (Baumwell, Tamis-LeMonda, & Bornstein, 1997; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991). Calandrella & Wilcox (2000) state that "maternal verbal responsivity" (e.g facilitative input) mediates the relationship between intentional communication and subsequent language outcome; in addition, they postulated that "children who engage in high rates of interpretable communicative acts (mostly intentional) may receive more explicit vocabulary models, coupled with naturalistic contextual support, thereby increasing overall vocabulary size". Contingent responsiveness is important for the development of speech and language, as research suggests that vocal turn taking may facilitate development of spoken language (Locke & Pearson, 1992). Stoel-Gammon (1992) reports, "It seems that when adults respond contingently (e.g. with a phonetically similar form), during the infant's turn, his or her vocal output may become more speech-like" (p. 114).

Interestingly, in research on maternal-infant responsiveness by Van Egeren, Barratt, & Roach (2001), mothers who were documented to use high rates of vocalizations or smiles were not especially likely to have infants who vocalized frequently. However, mothers who *contingently* vocalized had infants who contingently vocalized, and mothers who *contingently* smiled also had infants who contingently smiled. Therefore, the authors concluded that dyads could be distinguished not from displays of relatively similar quantities of behavior, but instead by parallel patterns of responsiveness toward one another. The authors go on to suggest that the fact that mothers and infants in this study did not necessarily behave with relatively similar frequencies, but did have similar levels of contingency, suggests that a process of coregulated interaction over time may be at work. In this case contingently responsive mothers may gradually shape their infant's communication patterns toward mutual similarity (Barratt, Roach, & Leavitt, 1996).

Interactions of Premature Infants and Their Caregivers

The quality of the mother-infant relationship is known to affect infant health and developmental outcomes in premature infants (Berlin, Brooks-Gunn, Spiker, & Zaslow, 1995; Singer et al., 2003; Thompson et al., 1997). A substantial number of studies have documented interactional patterns that distinguish preterm from full-term infants (Barratt et al., 1992; L. Davis, Edwards, & Mohay, 2003; Magill-Evans & Harrison, 1999;

Mathisen et al., 2000). Interactions between premature infants and their caregivers have been found to be very different from those of full-term infants and their caregivers, with preterms intitating interaction less often, providing fewer distinct cues to the caregiver, and demonstrating less positive affect as observed by exhibiting less smiling, less looking, increased fussing, and more communication breakdowns (Davis et al., 2003; Mathisen et al., 2000). Premature infants are therefore noted in the literature to be "less responsive social partners" (Davis et al., 2003), and mothers of premature infants are reported to work harder to initiate and maintain interactions while receiving fewer positive responses (Singer et al., 2003). The literature shows that such differences between the interactions of premature infants and their caregivers persist beyond the first year of life (Barratt et al., 1996).

Interactions of African American Premature Infants and Their Caregivers

Holditch-Davis, Schwartz, Black, & Scher (2007) reported that African American premature infants exhibited even fewer social behaviors than white premature infants. Therefore, mothers of African American premature infants may have to work even harder than mothers of other prematures to engage their infants in communicative exchanges and maintain social interactions. Research has also documented that African American mothers of premature infants have been shown to talk less and show less warmth in interactions with their infants when compared to white mothers, even when SES was controlled (Cho, Holditch-Davis, & Belyea, 2004). The interplay of poverty, decreased maternal education, and depression experienced by some rural African American mothers may result in parenting styles that are thought to be less facilitative of development, as these factors could lead to decreased caregiver contingent responsiveness. However, low-income African American mothers with larger support networks have been shown to be more responsive in interactions with their infants than mothers with smaller social networks (Burchinal, Follmer, & Bryant, 1996), thus supporting the need to utilize a systems model when examining parenting behavior and child development in this population. In addition, a transactional framework that considers the impact of both caregiver and infant contributions to social communicative interactions is important in examining the communication development of African American premature infants.

Feeding Development

Feeding interactions between caregivers and infants occur multiple times each day, and provide the earliest context for social communication (Satter, 2000). During these interactions, the caregiver guides the process while the infant communicates reciprocally as to what he or she needs in the moment (e.g. stop to rest and breathe). The caregiver's role then becomes one of responding appropriately to the infant's experiences and cues. During feeding interactions mother and child engage communicatively, and research shows that most infants are communicating via behaviors such as facial expressions, body movements, and later gestures during feeding situations throughout the 2 to 24 month period (Mason et al., 2005). Even premature infants are able to communicate via behaviors that cue caregivers as to infant physiological readiness and engagement during feeding (Thoyre & Brown, 2004). The transactional "conversations" that take place during feeding interactions demonstrate the reciprocal give and take of this relationship such that mother and child are mutually engaged and both co-regulate the experience (Fogel, 1993). The following sections highlight the developmental changes that occur in feeding during the first year of life, as well as the concerns that can arise with a breakdown in the feeding system that results in feeding problems.

Developmental Milestones in Feeding Skill Development- The First Year

For all infants the developmental “work” of feeding involves the coordination of sucking, swallowing, and breathing mechanisms to successfully and safely consume breast milk or formula. Although eating is regarded as a basic function, it is in fact a complex motor task that requires oral motor skills for sucking and bolus formation to be coordinated with breathing and swallowing. In fact, the coordination of sucking, swallowing, and breathing is a complicated, integrated process involving the coordination of more than 20 pairs of muscles and 5 cranial nerves (Miller, 1986). This coordination requires both the neurological maturation to control and adjust the intricate movements of physical structures and muscles, and the synchronization of timing and rhythmicity in the suck, swallow, and respiratory functions (Gewolb et al., 2003). For most healthy, full term infants, this coordination and the subsequent feeding interactions that occur between caregiver and child appear to be effortless.

Caregiver and infant roles during feeding interactions. Currently researchers are recognizing the contributions that both the mother and the infant bring to the feeding interaction, and the focus is therefore on the dynamic exchange of the mother-infant dyad (Diane Holditch-Davis, Miles, & Belyea, 2000). Barnard (1990) theorized that the infant, as well as the mother, plays a crucial role in the exchange of interactions. In addition, Humphry (1991) stated that the parent-infant relationship can be viewed within the context of the feeding interaction, which can be understood as a transactional model (Sameroff & Chandler, 1975). In such a model the strengths of one member of the dyad can compensate for difficulties experienced by the other member. During this give and take exchange during feeding, mothers and infants work together and share control of the experience, while also having their own roles in the interactions. For example, Satter (2000) states that parents are responsible for the what, when, and where of feeding, while infants and young children are responsible for the how much and whether of eating. The caregiver's responsibilities during feeding include tuning in to the baby's rhythms and being sensitive to infant cues, helping the baby to be calm and organized, alleviating stress when possible, and providing growth-fostering situations (Mentro, Steward, & Garvin, 2002). The role of the infant during feeding interactions is to display clarity of cues and responsiveness to the caregiver (Mentro et al, 2002; Barnard, 1990). According to Mentro et al (2002), Barnard's (1990) description of infant feeding responsiveness is the most widely used in the professional literature; Barnard defines infant feeding responsiveness as "the ability of the infant to respond to communication and interaction attempts made by the caregiver." However, Mentro et al (2002) state Barnard's description is somewhat vague, and suggest other behaviors that further delineate infant feeding responsiveness such as: the infant stops crying when the caregiver attempts to soothe her/him, looks in the direction of the caregiver's face when the caregiver talks, sucks and makes feeding sounds following attempts by the caregiver, and vocalizes or smiles after the caregiver vocalizes or smiles.

With the transition from bottle or breastfeeding to the introduction of solid foods, the roles of both the caregiver and the infant begin to change, as the infant becomes more skilled in gross motor (e.g. sitting up supported or on own) and fine motor abilities (e.g. holding own bottle, reaching for or holding spoon or solid foods). The following sections describe the skills needed by the infant to successfully bottle feed, and those needed to begin to make the transition to spoon feeding.

Bottle feeding. The full term infant has strong oral reflexes that enable him or her to take in liquid nutrition without difficulty. The sucking pattern of the full term infant is rhythmic, sustained, and efficient, diminishing appropriately with satiation. Infants who are good feeders are described as having sucking patterns that are fast and strong, as well as stable and rhythmic (Glass & Wolf, 1998). The infant's first pattern of sucking is termed suckling (Morris & Klein, 2000). Suckling predominates during the first 4 months of life. This early and immature sucking pattern may cause slight liquid loss and intake of air, but by about four months of age the tongue begins to move up and down, less liquid is lost, and suction on the nipple increases. Also, by 3-4 months of age the infant sequences up to 20 or more sucks from the bottle before pausing. Breathing slows during sucking and occurs within and between sucking sequences, therefore, the infant may occasionally cough or choke when he or she momentarily loses coordination of sucking, swallowing and breathing.

By approximately 6 months of age infants are able to better coordinate sucking, swallowing, and breathing, with less coughing or choking. Indeed, coughing and choking are rarely seen in full-term healthy infants during bottle feeding by this age (Case-Smith & Humphry, 2001). At this point in oral-motor skills development, infants demonstrate strong up and down tongue movements, with minimal jaw excursions. The six- month-old infant usually has a good lip seal, such that the infant does not lose liquid when sucking on the nipple. Some older infants may begin to show interest in holding their own bottle, stopping their sucking occasionally to smile or vocalize to the caregiver while being held during bottle feeding. Other infants and caregivers use the time during bottle feeding for quiet cuddling with decreased communication and interaction; infants may become sleepy during bottle feeding, and drift off for a nap while being held.

Spoon Feeding. The American Academy of Pediatrics currently recommends that an infant be only fed breastmilk or formula for the first 4-6 months of life, and that the introduction of solid foods should occur gradually beginning around 6 months of age (American Academy of Pediatrics, 2005). Many households do not adhere to these recommendations, and there is a wide range of ages at which solid foods are currently introduced by parents. The timing of the introduction of solid foods is, in part, the result of social and cultural mores of the family, as well as the health status, physical wellness, and developmental readiness of the infant (Carruth & Skinner, 2002; Kannan, Carruth, & Skinner, 1999). African American mothers in particular have been found to introduce solids to their infants at an earlier age, often as early at 2-3 weeks of life (Bentley, Gavin, Black, & Teti, 1999; Bronner et al., 1999; Corbett, 2000; Underwood, Pridham, Brown, Limbo, & Thoyre, 1997). Such early introduction of solids most often includes the addition of cereal to the milk bottle (Corbett, 2000).

Between the ages of 4-7 months, most infants are developmentally ready to take cereal or pureed baby food from a spoon (Satter, 2000). Developmental readiness for spoon feeding includes head and trunk stability with supported sitting, and research shows that many infants are able to sit up unsupported between 5-6 months of age (Carruth & Skinner, 2002). With regard to the oral-motor skills required for spoon feeding, it is reported that by 4-5 months of age most infants use a rhythmic, stereotypic, phasic bite and release pattern on almost any substance placed in the mouth (Case-Smith

& Humphry, 2001). When this type of bite is used in a repeated rhythm, it is called a munching pattern. This movement is characterized by the jaw moving in the vertical direction, and the tongue moving in extension and retraction. By 7-8 months of age the infant begins to use more of an up and down munching pattern. When the older infant receives food on a spoon, the upper lip actively cleans it from the spoon, and the lips become more active during sucking and maintaining the food within the mouth. The infant does not typically gag on ground foods or soft semisolids at this age (Wolf & Glass, 1998).

When feeding interactions go smoothly, Satter (2000) describes the give and take of mealtimes as “a sort of nonverbal, nicely flowing conversation”. In her book entitled, *Child of Mine: Feeding With Love and Good Sense*: she describes for parents the communication that can take place during mealtimes, and the importance of this social interaction.

> Your participation in the back and forth communication of spoon feeding helps him understand cause and effect and to *know* on a deep level that you pay attention and that he can get what he wants…he needs to tell you what he wants and have you listen and respond…When you offer your baby a spoonful of food and wait for his response, and he opens his mouth and leans over to let you know that he wants it, you are communicating in both a sophisticated and fundamentally important way. When you further honor his communication by putting the spoon in his mouth and leaving it there long enough for him to remove the food from the spoon, you show him you are willing to let him take the lead and you encourage him to “talk” with you. You are enacting a communication and relationship

> pattern that is transformative for him- in his as well as your eyes- and essential to his relationships with other people (p. 253).

This example beautifully illustrates the transactional nature of mealtimes when both caregiver and child are healthy, engaged, and interacting as both communicator and receiver during the spoon feeding interaction. However, breakdowns in this communication can take place if one or both partners in the dyad experience physical, physiological, or interactional difficulties that result in feeding difficulties.

Feeding Difficulties

Children impacted by premature birth, neurological impairments, physical differences such as congenital malformations, and respiratory or cardiac problems, often face many feeding difficulties. Such difficulties can subsequently impact not only the child's feeding skills, but also the feeding relationship with the caregiver. In children with developmental delays, an estimated 30-80% exhibit some type of feeding or swallowing problem (Schwarz, 2003). Factors that suggest swallowing problems include gagging or choking, and repeated ineffective swallows (Case-Smith & Humphry, 2001). Many times aspiration (e.g. the passage of fluid or food into or beyond the airway) may be silent, and the only indications of a mistimed swallowing event may be wet, noisy respiration after feeding or the occurrence of repeated respiratory infections (Benson & Lefton-Greif, 1994). Early feeding dysfunction is often considered to be an early indicator of possible neurological problems, which may result in future diagnoses of language or developmental delays (Hawdon et al., 2000; Selley et al., 2001). Therefore, early feeding struggles could be "red flags", indicative of future developmental problems that would require ongoing supports and services for the child and his or her family.

Severe feeding problems that are persistent over time may result in serious conditions such as malnutrition, nutrient deficiencies, delayed development, failure to thrive, and excessive family stress (Olive, 2004; Sullivan et al., 2000). Infants who are born prematurely, and/or with diagnoses of neurological insults or respiratory disorders, have been found to be at greatest risk for feeding problems (Hawdon et al., 2000). Breathing is the infant's number one physiological priority; therefore, respiration, as well as heart rate, must be stable for the infant to be physiologically ready and able to engage in feeding interactions. Increased respiratory rates result in decreased time to coordinate swallowing with breathing, which can lead to aspiration; often, aspiration leads to chronic respiratory problems (Sheikh et al., 2001). In addition to the physiological considerations of respiratory rate and compromise, secondary medical diagnoses such as gastro-esophageal reflux or GER (Mercado-Deane et al., 2001), and renal failure (Mason et al., 2005), can also contribute to breathing and swallowing difficulties and further exacerbate feeding problems.

Coordination of swallowing and breathing becomes more effective and efficient with maturation (Nobrega, Borion, Henrot, & Saliba, 2004), but for some children, feeding problems appear to persist beyond infancy (Hawdon et al., 2000). Medical complications such as gastro-esophageal reflux contribute to age-related changes in food refusal; such age-related changes occur as a result of growth, cognitive and motor development, and increased autonomy. For example, Gisel (1991) reported that the refusal rate of foods in infants with cerebral palsy increased from 7% at 6 months of age to 41.4% by 24 months of age on specified foods, as reported by parents on feeding history questionnaires. In infants who were tube fed, changes in feeding problems have also been documented with increased age (Mason et al., 2005), reflecting a developmental progression and potential sensitive periods. For example, in a survey study of children with cerebral palsy and dysphagia who were born prematurely, Selley et al. (2001) documented maturational changes in feeding problems based on parent reports. The authors of this study were surprised at the finding that 27% of mothers did not report any early suckle feeding problems, but reported severe feeding problems in their children at older ages (Selley et al., 2001). The authors asked the question "what went wrong after weaning?" for those infants who were reported initially to feed normally during suckle feeding. Interestingly, the authors did not consider the possibility that this subgroup of children whose early eating appeared fine may have been unable to make a successful transition beyond a suckle pattern to more mature oral-motor patterns (e.g. rotary chewing) for eating, resulting in struggles with transitions to textured and solid foods. Such inabilities to transition to more mature oral motor patterns could theoretically contribute to later speech and language delays, as is discussed in the following section.

Theoretical Contributions of Feeding Problems to Later Speech and Language

The production of speech sounds is reliant on the control of physical structures as well as physiological stability. Both physical and physiological factors are important in a variety of skills related to speech and language and can have an impact on production. For example, chronic breathing problems could possibly contribute to later difficulties in the ability to coordinate breath support for speech and language (Gewolb et al., 2003). In addition, uncoordinated or dysfunctional early sucking skills may have a negative impact on later feeding and oral motor development and ultimately on speech. Due to the fact that coordinated oral-motor patterns are needed for speech sound production, dysfunction or disorganization of such patterns that initially impact feeding in infancy could have a negative cascading effect. Such an effect could lead to later speech and language delays or difficulties with regard to the coordinated oral motor movements required to produce speech sounds (Nobrega et al., 2004). For example, before an infant can use speech to communicate, tongue control must be developed for coordinated movements such as tongue elevation; this skill is initially learned within the context of the development of feeding skills (Skinner et al., 1998).

When considering communication development within the context of early social interactions such as feeding, the co-regulation and engagement required for learning in this context can also be considered with implications for later language learning (Fogel, 1993). In this regard, an important question remains from what we know about co-regulation and mutual engagement during social interactions: if communicative behaviors or cues are overridden by adults during early feeding interactions, what are the possible implications of such caregiver behaviors on future social interactions which will provide the context for infant speech and language development (Skinner et al., 1998). An example of such a scenario can be found in Thoyre and Carlson's work, (Thoyre & Carlson, 2003) where mothers were documented to often resume feeding their premature infant after an oxygen desaturation event, before the infant's oxygen saturation had recovered to the pre-feeding baseline levels. This lack of responsivity by the mothers indicated a breakdown in the communication between caregiver and child, as the caregiver was unaware of or unable to read the physiological and behavioral cues signaled by the infant. Such communicative breakdowns are not solely the result of caregiver inability to read infant cues, as preterm infants also struggle with the ability to maintain engagement and arousal states during feeding. Research has further demonstrated that infant ability to maintain engagement in feeding is determined by characteristics of the dyad, in addition to the dynamic conditions created within the feeding interaction (Thoyre & Brown, 2004). Deficiency of feeding skills on the part of either the parent or the infant has a major impact on these dyadic interactions, as well as on the infant's growth and development of mental and motor skills (Pridham, Limbo, Schroeder, Thoyre, & Van Riper, 1998).

When considering early feeding interactions and their possible contributions to later speech and language development, one must also consider research that documents continued feeding problems in older children with speech and language delays. One such example is a study by Sullivan et al., (2000) which documented speech and language delays and disorders in children aged 4 to 13 years who had cerebral palsy and feeding problems (Sullivan et al., 2000). Of the 377 children whose parent report questionnaires were in this cross-sectional study, 89% of the children were reported to need help with feeding, while over half were reported to choke with food. These feeding problems resulted in increased time spent feeding the children with disabilities, which subsequently resulted in many of the parents reporting feelings of increased stress and lack of enjoyment when feeding their child. Such results, in combination with caregiver documentation that 64% of these children had never had their feeding or nutrition formally assessed, led the authors to state that feeding problems are a common and under recognized source of increased stress for caregivers and family members of this population of children (Sullivan et al., 2000). In addition, 78% of these children were reported by their caregivers to have severe speech problems, providing at least a co-occurring if not causative link to earlier and concurrent feeding difficulties. These findings have contributed to theoretical assumptions that early feeding problems and dysfunctional motor patterns can lead to later speech and language delays.

The Relationship of Communication and Feeding Development

For decades, the existence of a relationship between early feeding and communication skills has been suggested in the literature. One example comes from a textbook on language disability in children, in which Treharne (1980) wrote a chapter entitled “Feeding Patterns and Speech Development”. In this chapter Treharne stated that, “Correct feeding patterns have been traditionally considered important for the normal development of speech… it has frequently been said that there is a close relationship between feeding patterns and speech development…the development of feeding patterns and of pre-speech vocalizations and the relationship between the two…suggests that development of the earlier occurring feeding patterns may influence subsequent vocalizations” (Treharne, 1980; p. 203). Such statements have been made in textbooks and research based journal articles across medical and allied health disciplines. For example, in an article in *The Occupational Therapy Journal of Research*, (Gisel & Pollock, 1988) wrote: “The ability to take in adequate food is essential for normal growth and nutritional development. It is also intimately related to the development of speech…”(Gisel and Pollock, 1988; p. 39). Despite these broad assumptions, little empirical research has examined feeding as a “pre-speech skill” (Morris & Klein, 1987). What little research does exist is not definitive as to the specific relationship, if any, between early feeding patterns or problems and later speech and language development.

Currently available information provides evidence for correlation, and at the very least co-occurrence, of feeding problems and speech disorders; yet the lack of empirical research that either confirms or refutes a specific relationship between oral-motor feeding skills and speech development creates a significant gap in our knowledge regarding early development. Also unclear in the literature is the link between early feeding communicative behaviors and later speech and language skills. Due to the fact that feeding interactions occur multiple times a day in natural contexts and environments, such information could theoretically drive both feeding and communication interventions with infants and their families.

Theoretical Support for a Potential Relationship: A Systems Framework

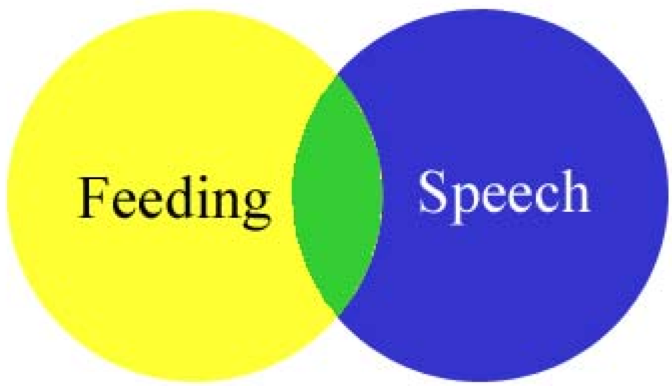
A potential relationship between the systems used for both feeding and speech can be considered within the context of General Systems Theory (von Bertalanffy, 1966). This theoretical construct identifies a system as two or more connected elements that form an organized whole and interact with one another (Claflin & Meisels, 1993). Components of this theory include: interaction within and between systems, boundaries, flexibility of systems to adapt to internal or external changes, and system-relatedness (e.g. change in any part of the system affects the whole). It was suggested by von Bertalanffy (1966) that a system is goal-directed and comprised of independent units, yet there is interdependence of units over time. Such a theory suggests that the structures and systems used for feeding could impact those used later for speech, and these two independent systems could also act interdependently over time. General Systems Theory has led to other, similar developmental theories that can also be considered in examining the theoretical support for a relationship between feeding and speech motor control systems. Dynamic systems theory and modeling is one such example, and will be discussed in the following section.

Dynamic systems models can be envisioned as being nested within general systems theoretical accounts used to explain the processes of typical development. Dynamic systems as a conceptual framework for examining development have been described in depth by both Thelen and Fogel (Fogel, 1993, 2001; Smith & Thelen, 2003; Thelen & Smith, 1995). To help elucidate potential relationships between the feeding and speech systems, a dynamic systems framework is postulated. Considering development within the context of a dynamic systems framework, the potential relationship between feeding and speech can be considered as development that occurs across complex systems over time. These complex systems contain many individual elements, including shared anatomical structures used for both feeding and speech, which are embedded within and are open to a complex environment. Dynamic systems models also incorporate terms such as “butterfly effect” and “perturbations” to describe how small changes in one area can have a large rippling affect on other areas or systems (Thelen & Smith, 1995). Perturbations can be defined as small changes in one or more component of the dynamic system that can result in a ripple effect, which subsequently can lead to reorganization in other systems and observable behaviors (Smith & Thelen, 2003). In considering both the feeding and speech systems, researchers can begin to recognize how perturbations within one infant system can impact all other physiological and behavioral systems (Mercado-Deane et al., 2001).

Morris and Klein (2000), state that there is a strong possibility that feeding and speech control systems are related, at least during the first year. They go on to suggest that feeding and speech may be related but not causal systems. The conceptual model for the current study is based on the belief that in the first year of life, feeding and speech systems can be viewed as separate yet overlapping dynamic systems. In considering these systems within such a conceptual framework, a perturbation in one of these dynamic systems could act as a rate limiter for both systems. Figure 2.1 illustrates the overlap between these two separate dynamic systems.

Figure 2.1

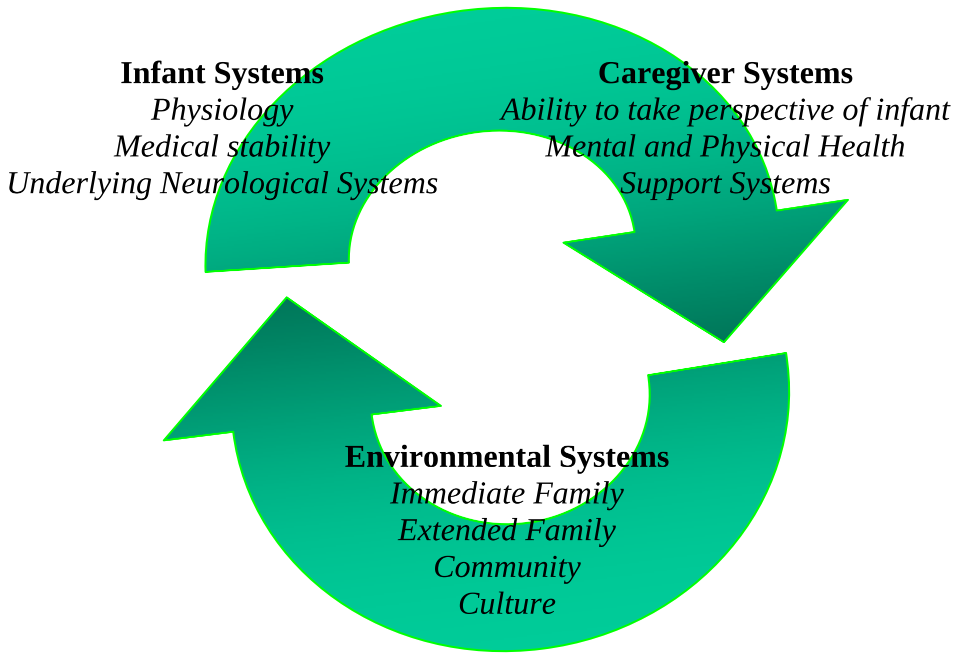
Conceptual Model



In addition, other systems could also impact the speech and feeding systems and result in perturbations that cause a ripple effect in either or both systems. These additional systems include those within the greater system of the infant (e.g. child characteristics such as underlying neurological systems, health status) and external systems that could impact the infant (e.g. the environment, caregiver characteristics). Figure 2.2 illustrates the possible interactions within and between these systems.

Figure 2.2

Dynamic Systems That Could Impact Feeding & Speech



Development in Premature Infants

The incidence of premature births continues to rise in the United States, with an increase from 12.5% to 12.7% from 2004 to 2005; the percentage of infants delivered at less than 37 completed weeks has risen 20% since 1990 (Martin et al., 2005). The March of Dimes reports that 1,400 premature infants are born in the United States each day (*March of Dimes: Premature Birth*, 2008). The Institute of Medicine reports that premature births and the care required for preterm infants require increased demands on the healthcare system, with an annual societal economic cost of at least $26.2 billion dollars in 2005, or $51,600 per infant born prematurely (Behrman & Butler, 2007). In terms of longer-term expenditures, early intervention services for formerly premature children cost an estimated $611 million, whereas special education services associated with a higher prevalence of four disabling conditions among premature infants added $1.1 billion.

African American women have the highest rates of premature birth, with 18% of all African American infants being born prematurely. The reason for increased rates of premature births in this population are not clear, however, proposed explanations include racial differences in genetics, young maternal age, and disparities by socioeconomic condition (Behrman & Butler, 2007). Therefore, rural, African American premature infants are at greater risk for developmental problems than other prematures (Berlin et al., 1995; Taylor, Klein, Scharschneider, & Hack, 1998; Thompson et al., 1997). Health disparities in this group of at risk prematures are the results of numerous variables including poverty, rurality with less local resources, mothers' emotional distress from premature birth and the resultant experiences in the NICU, and parenting impacted by all of these factors which can result in less contingently responsive caregiving (Berlin et al, 1995; Thompson et al, 1997). The following sections outline the communicative developmental differences as well as the unique feeding experiences of premature infants, and will focus on these areas as they relate specifically to African American caregivers and their premature infants.

Predictors of Later Developmental Delays in Premature Infants

Researchers have sought to find early predictive indicators of later developmental delays in very low birthweight (VLBW) infants who were born prematurely. One well researched screening tool that has been useful in predicting which VLBW premature infants at the time of discharge from the NICU are most likely to experience later developmental delays is the Neurobiological Risk Scale (NBRS, Brazy, Eckerman, Oehler, et al., 1991), which documents risk for later developmental problems due to neonatal events (Brazy et al. , 1993). The NBRS is highly correlated with the Bayley Scales of Development (Bayley, 1993), and identifies three potential risk groups of low (7%), intermediate (32%), and high (50%) risk for developmental delays at 24 months of age, based on increased NBRS scores. This screening tool has also been evaluated by Lefebvre, Gregoire, Dubois, & Glorieux, (1998), in a study that documented the ability of the NBRS to predict developmental outcomes at 18 mo of age in VLBW premature infants. It is of interest to note that in the above- mentioned study, birthweight alone did not prove to be a good predictor of later development.

Early identification of those premature infants most at risk for later developmental delays due to medical complications at birth is imperative for planning developmental surveillance. The NBRS (Brazy et al., 1991) appears to be able to identify those premature infants who will be most in need of continued developmental surveillance and follow-up resources from birth to three early intervention services. However, to the author’s knowledge, the NBRS has not yet been used in research that documents prediction of continued risk for developmental delays and learning disabilities in VLBW infants beyond the first two years of life. In addition, the NBRS cannot predict developmental outcomes with certainty because, as has been discussed earlier, the social environment also plays a significant role in child development (Lefebvre et al, 1998). Later screenings for communication and feeding difficulties in VLBW premature infants that take into consideration these skills within the framework of social interactions between the caregiver and infant could further contribute important information as to which infants may be in need of and benefit most from early supports and services. Such screenings and interventions that take into consideration the social interactions and environmental contributions to infant development could, in theory, provide supports for communication delays and feeding difficulties. Earlier interventions in these areas could possibly decrease delays or disorders in these areas, thus decreasing the amount of services needed for them by school age.

Communication Development in Premature Infants

There are conflicting reports in the literature as to the cognitive and communicative development of infants born prematurely; while some literature shows decreased cognitive and language scores as well as decreased social communicative abilities (De Groote, Roeyers, & Warreyn, 2006), other literature documents normal to near normal cognitive and language scores in older children who were born prematurely (Menyuk, Liebergott, Shchultz, Chesnick, & Ferrier, 1991). Some researchers state (Aram et al., 1991) that the lack of consensus appears to be related to methodological issues such as variability in the research studies in comparison to control groups matched by factors known to be related to speech and language development, such as social class of study participants, inclusion or exclusion of children with known neurological impairments as well as premature birth, age at follow-up, and speech and language measures used in research.

Language deficits accompanied by more general developmental problems have been reported in studies of older children who were born very low birth weight (VLBW) (Aram et al., 1991). There is also agreement in the literature that approximately 50% of those infants born at less than 1500 grams and/or those who were mechanically ventilated will go on to have some level of learning disability by school age, including reduced cognitive test scores and increased incidence of Attention Deficit Hyperactivity Disorder or ADHD (Bhutta et al., 2002). However, no research to date has been able to delineate exactly which of these premature infants are most at risk and will be within the 50% impacted with mild to moderate disabilities by school age.

Despite documented differences in premature infants, there are also developmental systems that maintain a normal trajectory. For example, the development of canonical babbling remains stable on the typical developmental timeline; research shows that some healthy premature infants (e.g. those over 1500 grams at birth with no medical complications) even appear to develop canonical babbling at an earlier adjusted age than their full-term counterparts (Eilers et al, 1993; Oller et al, 1994), perhaps due to earlier opportunities to hear and experience speech sounds. In contrast, other research has found that in infants with very low birth weights (VLBW) very little canonical babble was produced at 8 months of age, but these infants were performing within the range of the full term infants in the study at 18 months of age (Rvachew, Creighton, Feldman, & Sauve, 2005). However, prematures with other risk factors, such as bronchopulmonary dysplasia (BPD), were reported to have significantly smaller expressive vocabulary sizes than the healthier preterm and full-term infants. Therefore, there may be conflicting findings due to differences in research that has examined communication development in healthier premature infants with regard to the evidence that some premature infants "catch up" to full term infants in some developmental domains.

Feeding Development in Premature Infants

While sucking develops and can be observed on ultrasounds in utero at 15-18 weeks gestation, the well coordinated, efficient sucking needed for feeding does not generally develop until around 32-34 weeks gestation (Arvedson & Brodsky, 2002; Wolf & Glass, 1992); therefore, premature infants typically are fed by non-oral means through 33-34 weeks gestational age. Before this age the premature infant does not have the sucking endurance or strength for oral feeding (Case-Smith & Humprhy, 2001). Sucking bursts are described as disorganized and short in infants between 29-30 weeks gestation. As the coordination between sucking and swallowing becomes more fully developed, oral feeding is more likely to be successful.

Premature infants born at less than 34 weeks gestation are typically not yet neurologically mature enough to engage in oral feeding (Nobrega et al., 2004). However, while the emergence of a mature sucking pattern is not typically observable until approximately 34 weeks gestation, (Burklow, McGrath, & Kaul, 2002) research is beginning to show that the initiation of oral feeding before 33 weeks post menstrual age is feasible for some premature infants, and also allows for earlier attainment of all oral feeding than previously observed (Simpson, Schanler, & Lau, 2002). Such research documents that earlier bottle feeding can be successful in infants with immature sucking, but whether these infants in particular will go on to continue to use immature sucking patterns or struggle with later feeding has not been examined.

For premature infants and others born with neurological or congenital impairments, feeding often must occur initially via naso-gastric or oro-gastric tubes, also referred to as gavage feedings (Mason et al., 2005). Tube feeding is commonly used in neonatal units due to the immature neurological and digestive systems of premature infants. Although extended tube feeding may be required as a result of multiple medical complications, data suggest that later oral sensitivity and decreased feeding skills may result from the long term use of feeding tubes (Dodrill et al., 2004; Mason et al., 2005). Breathing problems can also both cause and contribute to feeding problems. Such issues are prevalent in preterm infants, as they have an increased incidence of chronic lung disease and respiratory distress syndrome (Gewolb et al., 2003). Those infants who have been weaned from oxygen supplementation and are stable on room air may still demonstrate respiratory compromise during feedings. This suggests that the increased physiological demands of feeding may require oxygen supplementation at these times to prevent the loss of oxygen reserves and subsequent hypoxemia (Thoyre & Carlson, 2003).

Many young children with a history of prematurity and VLBW have long-term problems with poor feeding and growth (Burklow, McGrath, Valerius, & Rudolph, 2002). Prospective data indicate that approximately 31% of infants cared for in a NICU will experience difficulties with feeding at or prior to 1 year of age (Hawdon et al., 2000), and retrospective data have shown that almost 40% of children referred to an outpatient clinic specifically for feeding and growth concerns long after NICU discharge have a history of preterm birth (Burklow, McGrath, & Kaul, 2002). In addition, infants who are initially regarded as normal feeders in the NICU can exhibit feeding problems between 6 months to 1 year of age (Burklow, McGrath, Valerius et al., 2002; Hawdon et al., 2000). Therefore, both premature infants who struggled early on with bottle or breastfeeding, as well as infants who did not demonstrate early problems with feeding may go on to be at risk for later feeding struggles with both the changes in anatomical structures that come with development, and the increased demands and expectations that come with the transition to solid and spoon feeding.

In other research, Mathisen et al. (2000) examined feeding difficulties and dysphagia in 6 month old infants who were born extremely low birthweight (ELBW). This study documented inconsistencies in early oral motor skill development in the ELBW infants as compared with control infants, with 80% of the premature infants demonstrating continued and ongoing feeding problems. In addition, the ELBW prematures were found to exhibit fewer smooth sequences in their mealtimes, fewer readiness behaviors for solids, and were less socially interactive at mealtimes with less vocalizations documented when compared to their full term counterparts. Mathisen and her research team (2000) stated that further research is needed to confirm their findings of significant and ongoing feeding problems in ELBW premature infants at 6 months of age. This research also documented the need for further studies to investigate the relationships between early feeding dysfunction and later communication and eating difficulties in formerly premature infants.

African American Premature Infants

As has been stated earlier, rural African American premature infants are most “at risk” for later developmental problems, due to many factors and health disparities which include increased overall rate of premature births in African American women, poverty, limited access to resources in rural communities, and minority status (Berlin et al., 1995; Msall & Tremont, 2002). Holditch Davis et al. (2007) reported that African American premature infants exhibited even fewer social behaviors than white premature infants.

Other research has documented that African American mothers of premature infants, in turn, have been found to talk less and show less warmth in interactions with their infants when compared to white mothers (Cho et al., 2004), and to introduce solids to their infants at an earlier age, often as early at 2-3 weeks of life (Bentley et al., 1999; Bronner et al., 1999; Corbett, 2000; Underwood et al., 1997). While these infants have been found in the literature to be most at risk for later developmental problems, no research to date has specifically examined the communication and feeding skills of African American premature infants at 6 months adjusted age and the relationships that may exist between these earlier behaviors and later language development. The results of the previously mentioned study by Mathisen et al (2000), coupled with their recommendations for further research on the feeding and communication development of premature infants, warrants research examining these relationships in those premature infants most at risk for developmental delays, specifically, African American premature infants.

Summary of Relevant Literature

In conclusion, this review has discussed several aspects of early communication and feeding skills development, emphasizing the significant developmental changes that occur during the first year of life. Specifically, these skills were discussed as they relate to the developmental trajectories of premature infants. In addition, feeding problems and the possible theoretical contributions of early feeding dysfunction to later speech and language development were reviewed. Based on a theoretical framework that incorporates concepts from transactional, ecological, systems, and specifically dynamic systems perspectives, it is suggested that the speech and language of formerly premature infants may be impacted by earlier experiences with communication and feeding interactions. Findings within the literature imply that later language in formerly premature infants may be at risk or impaired; what is unknown, however, is which infants are most at risk by school age for learning disabilities such as communication delays and disorders. Although a relationship between early feeding skills and later speech and language has been suggested in the literature, there is a paucity of empirical research which either confirms or refutes that such a relationship in fact exists.

Another key factor in considering the impact of early development on later skills is that of the caregiver's level of engagement and interaction with the infant both during mealtimes and at other opportunities for social interaction with the infant. Opportunities to observe and document infant communication such as vocalizations and early gestures, oral-motor feeding skills, and caregiver levels of engagement and ability to read and respond to infant cues may be increased by looking at these areas of infant and caregiver behaviors before, during, and after mealtimes.

There is a paucity of research in the areas of communication and feeding development in premature infants, feeding problems in this population, and their relationships, if any, to later language development. The research literature base that is available has not specifically focused on those premature infants at greatest risk for later developmental problems, namely, rural African American premature infants. Therefore, the current study was designed to examine the relationship between early oral-motor feeding skills, communication during feeding and nonfeeding interactions, and later language development in African American premature infants.

Focus of Current Study and Research Questions

The main purpose of this study was to determine whether oral-motor feeding skills and communicative behaviors observed during non-feeding and feeding interactions between premature infants at 6 months adjusted age and their caregivers were predictive of later speech and language and cognitive abilities as measured by standardized assessments at 24 months of age. A further purpose was to investigate whether early influences on the development of a group of African American premature infants would impact these infants' later developmental outcomes, including language development. A dynamic systems framework was used to address these questions, which included the examination of variables that could increase the infants "at risk" status prior to discharge from the hospital, as well the caregiver's global level of contingent responsiveness during both feeding and nonfeeding interactions at 6 months adjusted age. The research questions were therefore as follows:

1. Do early communicative behaviors at 6 months of age in preterm infants predict later speech and language skills as demonstrated on the scores of the *Preschool Language Scale-4* (PLS-4) (Zimmerman et al., 2002), as well as later cognitive scores that encompass language on the *Bayley Scales of Infant Development-II* (Bayley, 1993) at 2 years of age? It was expected that the amount and type of infant communicative behavioral acts during feeding and non-feeding interactions at 6 months adjusted age would predict later speech and language skills in this sample of premature infants.

    1.A. What aspects of early communicative behaviors (e.g. vocalizing acts, early pre-gestural acts) at 6 months adjusted age had the greatest predictive value for later speech and language skills in preterm infants?

1.B. What aspects of early communicative behaviors at 6 months adjusted age were the most predictive of Expressive Communication and Auditory Comprehension subscale scores on the PLS-4 (Zimmerman et al., 2002) at 2 years of age?

2. Do early oral-motor feeding skills at 6 months of age in preterm infants predict later speech and language skills as demonstrated on the PLS-4 at 2 years of age? It was hypothesized that early oral-motor feeding skills at 6 months of age in preterm infants would be predictive of later speech and language skills at 2 years of age. This hypothesis was based on the knowledge and clinical assumptions that the same oral structures used in feeding are used later in the production of speech, and that perturbations in one system may impact the other system. There will be two additional levels to this question:

   2.A. What aspects of early oral-motor feeding skills (such as rhythmicity of suck/swallow/breathe, lip seal, etc.) at 6 months in infants who were born prematurely were most predictive of later speech and language skills on the PLS-4 at 2 years of age?

   2.B. What aspects of early oral-motor feeding skills at 6 months of age in infants who were born prematurely were most predictive of Expressive Communication and Auditory Comprehension subscale scores on the PL S-4?

3. When considering early communication development within a dynamic systems framework encompassing both infant and caregiver variables, do early influences prior to discharge from the hospital and caregiver responsivity at 6 months adjusted age predict later developmental outcomes in this group of rural African American premature infants?

3.A. Which early indicators of possible developmental delays as recorded prior to hospital discharge had predictive value for later language scores in this group of premature infants? Such indicators could include decreased gestational age or birthweight, increased Neurobiological Risk Scores or NBRS (Brazy et al, 1993), and increased days on mechanical ventilation and length of hospital stay in days. It was hypothesized that early influences (before discharge from the hospital and at 6 months adjusted age) would predict later developmental outcomes.

3.B. Does global level of caregiver responsiveness during both feeding and nonfeeding interactions at 6 months adjusted age predict infant language and cognitive scores at 2 years of age? The global level of caregiver contingent responsiveness during both feeding and nonfeeding interactions at 6 months adjusted age was also expected to predict both language and cognitive scores at 24 months of age.

CHAPTER 3

METHODS

The purpose of this study was to investigate whether early influences on infant development would impact later developmental outcomes, including language development, in this group of premature infants. The main purpose of this study was to determine whether oral-motor feeding skills and communicative behaviors observed during feeding and non-feeding interactions between preterm infants at 6 months adjusted age and their caregivers were predictive of later speech and language abilities as measured by standardized assessments at 24 months of age. Data for this current study were coded and analyzed from an existing dataset of a project entitled "A nursing support intervention with mothers of preterm infants", (also called the MOMS Project), of which Diane Holditch-Davis, RN, MS, PhD, FAAN was the principal investigator (Holditch-Davis, 2007). This completed longitudinal study was conducted in the School of Nursing at the University of North Carolina at Chapel Hill, and was funded through an R01 (NR035962) from the National Institute for Nursing Research, NIH (final report to NINR, 2007). For the current study, infant oral-motor feeding skills during bottle or spoon feeding and communicative behavioral acts before, during, and after a mealtime were coded from home video footage from an existing data set of premature African American infants and their caregivers. Specifically, information obtained from the videotape footage at 6 months adjusted age was examined to determine relationships between these data and later standardized language scores of the participants at 24 months of age.

Design and Recruitment for the MOMS Project

The original MOMS research team aimed to test the effects of a support intervention for rural, African American mothers and their premature infants who were at high risk for developmental problems. For each mother infant dyad the study took place from the time the infant was in intermediate care until 24 months corrected age. Mothers were enrolled in the study during their infant's hospitalization when the infants were no longer critically ill. A two group design with mothers randomly assigned to either the nursing support intervention or usual care groups was used to examine the effects of the intervention on areas such as maternal psychological well being, mother child relationship quality, and child development outcomes. The intervention included an initial contact with the mother while the infant was still in the hospital, home visits at 1-2 weeks after the infant was discharged home and later at 6, 12, and 15 months of age, and a series of phone contacts. Baseline data were collected at enrollment. Infant illness and medical complications information was obtained from a review of the infant's medical records prior to discharge home. Outcome data were collected for all infants at 2, 6, 12, 18, and 24 months (Holditch-Davis, 2007). Infant outcome data included language and cognitive scores obtained at 12 and 24 months from the *Preschool Language Scale-4* (Zimmerman, et al., 2002) and the *Bayley Scales of Infant Development* (Bayley, 1993), respectively.

Child Participants

Participants for the original R01 MOMS study were recruited from the neonatal intensive care and intermediate care units of two North Carolina hospitals: North Carolina Children's Hospital in Chapel Hill, NC, and Pitt County Memorial Hospital in Greenville, NC. These sites were selected for the original study because they served similar populations and provided developmental surveillance services. All infants were less than 35 weeks gestational age at birth and considered high-risk for developmental and health problems because they either weighed less than 1500 grams at birth or required mechanical ventilation. Infants in the larger study had a mean birth weight of 1106 grams (SD 394), a mean gestational age in weeks (GA) of 28.3 (SD 2.9), and 42% of the original MOMS study participants were male. Preterm infants weighing less than 1500 grams and mechanically ventilated preterm infants have similar rates of developmental problems (Blackman & Hein, 1985; Korkman, Liikanen, & Fellman, 1996). Infants were excluded from the original study if they had genetic and/or congenital neurological problems (such as Down Syndrome, microcephaly) or were symptomatic for substance exposure, were hospitalized more than 2 months post-term, or were part of a birth that included more than two infants (Holditch-Davis, 2007).

Caregiver Participants

Mothers who participated in the original MOMS project study were African American women who gave birth to either singleton or twin premature infants. Participants were treated at NC Childrens or Pitt County Hospitals and lived in one of the 82 counties defined as rural or small town because they lacked a metropolitan area with a population of 60,000 or more. A total of 177 African American biological mothers of prematures and their infants were involved in the original study, with 90 participants in the control group and 87 in the intervention group. Exclusion criteria for mothers included: younger than 15 years of age, substance abuse, no custody of the infant, follow-up for two years was unlikely, maternal history of bipolar or current diagnosis of major depression, use of antidepressants, ongoing maternal critical illness, non-English speaking mother, or if obtaining consent was considered intrusive due to family situation (such as maternal HIV). Because some participant mothers may have been depressed, measures such as questionnaires of maternal anxiety, depression, and need for support were used in the intervention group to provide nursing support services. In the MOMS Project the average maternal education level in years was a mean of 12.6 (SD 1.8), and the average maternal age was 25.9 years (SD 6.5).

Procedures for Current Study

Sample Size and Subject Selection

In order to determine sample size for the current study, a preliminary a priori power analysis was conducted to determine the number of participants needed. A sample size of 50 subjects was determined to allow for a minimum R squared of 23 percent or higher with a power of .80 at a significance level of .05 if 5 variables were entered into a regression at one time (Hair, Anderson, Tatham, & Black, 1998). This would be the highest number of variables entered into any one regression for the individual statistical analyses employed for this study; thus, a sample size of 50 was targeted. Participants were chosen for this study from the larger MOMS Project sample based on the availability of at least five minutes of feeding footage (bottle or spoon feeding). The original study dataset included a total of 177 subjects, of whom 129 had videotape footage for the home visit at 6 months adjusted age. Due to the limited availability of videotapes with at least five minutes of feeding footage, the final sample size for this study was 42. This sample size included a total of 21 bottle feeding and 21 spoon feeding infants.

Participant Characteristics for the Current Study

Infants selected for this study had birth weights that ranged from 494 grams to 2110 grams, with an average birth weight of 1024 grams (SD 383). Gestational ages (GA) of the infants in the current study ranged between 24 and 35 weeks, with an average GA of 28.1 (SD 2.9) weeks. Also, in this study 38% of the participants were male (16 of the total 42 subjects).

Caregivers in this study had an average maternal education level of 12.8 years (SD 1.7) years. The average maternal age in this study was 26.3 years (SD 6.7). Approximately half of the mothers in this study were in the control group (20/42) in the larger MOMS project, and about half of the mothers were in the intervention group. Also, 50% of the mothers (21/42) in this study had been categorized as “depressed” in the MOMS project database based on caregiver questionnaires and interviews during the study.

Table 3.1

Demographic Characteristics of Infants and Mothers in MOMS and Dissertation Study

	Current Study			MOMS Study		
	N	Mean	(SD)	N	Mean	(SD)
Gestational Age in Weeks	42	28.1	(2.9)	177	28.3	(2.9)
Birth Weight in Grams		1024	(383)		1106	(394)
Sex of Child: Male		38.1%			42.9%	
Mechanical Ventilation (Days)		18.95	(22.8)		15.5	(26.5)
Maternal Age		26.3	(6.7)		25.9	(6.5)
Maternal Education in Years		12.8	(1.7)		12.6	(1.8)

As evident from Table 3.1, the smaller subset of children in the current study sample were very similar in terms of descriptive characteristics to the larger sample group.

Predictor Variables for Data Collected Prior to Hospital Discharge

Information obtained prior to infant discharge from the hospital that is typically used to predict developmental outcomes includes Neurobiological Risk Scores or NBRS (Brazy et al., 1993), gender, gestational age, birthweight, and length of time in days of mechanical ventilation and total hospital stay (Holditch Davis, 2007). This information was collected for each of the infants in the MOMS study. For the purposes of the current study, these separate "at risk" variables from data collected prior to discharge from the hospital were used in statistical analyses to determine whether they were individually predictive of later language scores at 2 years of age in this group of African American premature infants.

Development of Current Study Coding Systems

As no coding system currently existed that measured both communicative behavioral acts and oral-motor feeding skills or dysfunction, the researcher created the coding system based in part on currently available standardized assessments of early language and assessments of oral-motor functions during feeding. The development of the current study coding systems included the creation of four "red flags" severity scales with composite scores representing overall early communication over the course of the entire video, mealtime communication and oral motor feeding skills and dysfunctional behaviors for both bottle and spoon feeding.

The process of creating the coding system involved the researcher reviewing the literature and identifying behaviors that would be expected of typically developing infants between 6-9 months of age in the areas of feeding skills and communicative behavioral acts. The author then created a list of potential behaviors that might be observed in these areas in premature infants with adjusted ages of 6 months (and therefore in infants with chronological ages of 6 to 9 months). The researcher then sought the feedback of experts in the areas of communication development and feeding skills development in infancy, and feeding difficulties that could be specific to formerly premature infants. These experts were consulted to review the potential lists of behaviors to be observed in the study, and to assist the researcher in further description of and addition to the compiled lists of communicative acts and feeding behaviors to be noted for presence or absence in this research. Next, the researcher worked to phrase the composite scale items so that each "red flag" item would be given a score of "1", therefore a higher total composite score for each scale would indicate more "red flags" of possible communication and/or feeding difficulties. In addition, continued exploration of the literature to determine which communicative behaviors and feeding skills should be observable or emerging at approximately 6 months of age, and further consultations with experts in communication and feeding development in infancy assisted in final revisions of these items, which will be reviewed in the following section.

Communicative Behaviors. Specifically, the communication scales were created by determining communicative behavioral acts that if not observed in an infant between 6-9 months of age could indicate possible "red flags" of later communication difficulties. These behaviors included those that would be expected to be observed in infants between the ages of 0-9 months on the Preschool Language Scale-4 (PLS-4) (Zimmerman et al., 2002) in the areas of expressive and receptive language skills. In addition, communicative behaviors documented in the research literature to be most likely to occur in the first 9 months of life such as canonical babbling, which some research shows may be likely to be observed with earlier, though less stable emergence in premature infants (Eilers et al., 1993; Oller et al., 1994), were noted for presence or absence at 6 months adjusted age. Behaviors such as looking at the caregiver, vocalizing, and communicating nonverbally using gestures are hallmarks of early communication, as noted in detail in the literature review. Infant communicative behaviors coded in this manner included: looking at the caregiver's face, engaging caregiver, responding to caregiver, vocalizing non-crying sounds, engaging in vocal play, producing consonant-vowel (CV) or vowel-consonant-vowel (VCV) canonical syllables, producing CVCV canonical or reduplicated babbling, infant imitation of a sound, word or gesture, and infant gestures. The presence or absence of communicative behaviors was coded during the entire footage for each subject, as well as specifically during the mealtime footage. The presence or absence of each behavior was noted by circling "Yes" or "No" for each item on the coding sheet, and noting whether each behavior occurred more than once during the footage. In addition, detailed information with regard to infant vocalizations was documented to determine whether infants were engaging in canonical babbling, a higher level infant vocalization that emerges in the second half of the first year (Oller, 1999). The absence of these types of communicative acts may be indicators of later speech and/or language delays, and they were therefore considered "red flags" in this coding system.

Oral-Motor Skills and Feeding Behaviors. Oral-motor feeding skills documented in the author created scales were chosen and modified from some of those noted for presence or absence in a standardized assessment entitled *"The Objective Rating of Oral-Motor Functions During Feeding"* (SOMA, Reilly, Skuse, Mathisen, & Walker, 1995). The SOMA was developed to objectively record oral-motor skills in infants and young children from 8 to 24 months of age, and its aim is to identify areas of dysfunction that could contribute to feeding difficulties (Reilly et al., 1995). The SOMA has been found to be a reliable and comprehensive assessment of infant oral-motor function (Skuse, Stevenson, Reilly, & Mathisen, 1995). Reliable items in documenting areas of dysfunction that could contribute to feeding difficulties on the SOMA include: panic reactions, coughing or choking, liquid or food loss, and lack of adequate lip seal on the nipple (Reilly, 1995). These items could be viewed as possible "red flags" of feeding problems and were chosen along with other expected emerging oral-motor skills based on developmental norms (Glass & Wolf, 1998; Morris & Klein, 2000; Satter, 2000; Case-Smith & Humphry, 2001), and as expected to be found in children ranging in chronological age from birth to nine months. In order to address the research questions, the scales were used to document the presence or absence of communicative and oral-motor feeding behaviors.

Pilot Coding and Observations

As stated earlier, modifications and revisions to the coding system for each scale were discussed with experts in communication and feeding skills development in infancy. Modifications to the coding system included watching clips of videotapes of infants from the larger MOMS study that did not have the outcome data needed for the current study (no *Preschool Language Scale*-4 scores at 2 years), and piloting the coding system with expert consultants on numerous occasions to confirm behaviors observed and to clarify coding definitions.

The coding system for the study was piloted on 10 non-study participants to test the overall coding system and to refine the system and definitions of the codes. Participants were chosen at random for pilot coding from those participants with at least 5 minutes of feeding footage for whom there was no outcome data, and therefore, these pilot participants could not be used for the current study. Segments for training the research assistant for reliability coding purposes came from these initial pilot videotapes. Please see the Appendix for more detailed definitions and examples of each behavior on the scales.

Coding of Behaviors

The coding systems are outlined below, and the complete coding manual can be found in the Appendix. The coding systems involved four total scales over the three domains of overall communication, mealtime communication, and oral-motor feeding skills; oral-motor feeding scales were in two versions, one for bottle feeding subjects and one for spoon feeding subjects.

Overall Early Communication "Red Flags" Severity Rating Scale. The presence or absence of nine types of communicative behavioral acts were documented by examining all available footage for each subject. Specifically, the coder documented the presence or absence of behaviors such as engaging and responding to caregiver, vocalizations, and non-verbal or pre-gestural communicative acts. The nine communicative acts that appear on the scale and their definitions appear below.

1.) *Looking*- infant looked at caregiver's face for at least 2 continuous seconds
2.) *Engages*- infant smiled or vocalized and successfully gained attention of caregiver, engaging him or her in an interactive and reciprocal exchange
3.) *Responds*- infant responded to a communicative bid from caregiver, by smiling, turning when his or her name was called, vocalizing, or gesturing in response
4.) *Vocalizes*- infant made **any non-crying** soft, throaty, gurgling sounds; grunts, vowels, squeals or consonant sounds; or raspberries
5.) *Vocal play*- infant made sounds that sounded like he or she was "playing" with voice; examples include long vowel sounds that change in pitch and intonation, and loudness, or strings of full vowel like sounds with contrasts among the vowels, strings of squealing sounds
6.) *Canonical syllables*- infant produced a clear consonant sound (C) in combination with a vowel sound (CV, VC). Adult like, rapid timing should

be clearly heard between the C and V, resulting in a clear CV or VCV syllable. Examples: ma, aba, ba, up.

7.) *Canonical babbling*- infant produced a combination of CVCV sounds or reduplicated babbling with adult like, rapid timing; examples include: mama, dada, baba

8.) *Imitation*- infant imitated or clearly attempted to imitate a sound, word, or gesture immediately following an adult model

9.) *Gestures*- infant produced nonverbal communicative bids with either hand and arm movements or whole body movements; only those nonverbal acts that appeared intentional and clearly served a communicative function were documented; infant was required to persist and to look and/or vocalize to the caregiver while doing the gesture to indicate signaling behavior, also caregiver had to react and respond to the communicative bid.

The coder noted each instance with regard to the time on the videotape where the act was observed by writing the time in the space provided below each item on the scale. Composite scores were generated for the scale by totaling the number of shaded “No” items for each of the aforementioned communicative behaviors if the infant was never observed to engage in the behavior over the course of the videotape footage. As there were 9 total items on the scale, the worst possible composite score would be a 9, indicating that the infant was not observed to do any of the communicative behaviors as defined in the coding manual. Therefore, a score of 0 would indicate that the infant was observed to engage in all of the possible types of communicative behaviors over the course of the 45 minutes of 6-month adjusted age footage; this would be considered the best possible composite score on the scale. Please see the Appendix for the coding manual and more detailed definitions of each behavior as well as examples of what was and what was not considered an example of each behavior on the scale.

In addition to infant behaviors observed to generate the composite score, caregiver responsiveness and engagement were also documented. After watching the entire length of the videotape footage, the coder selected a "Yes" or "No" for the statement, "*Caregiver talks to and/or gestures to the infant*". In addition, a "Yes" or "No" was recorded for the following statements, "*Caregiver is responsive to infant communicative bids (fuss/cry/gestures)*" and *"Caregiver reciprocates/responds to social bids by the infant (affect/emotion/smile)."* A global level of caregiver responsiveness and reciprocation over the entire video footage was noted by checking one of the following: high (frequently responds to infant bids), occasional, rarely/almost never, never.

Mealtime Communication "Red Flags" Severity Rating Scale. The presence or absence of 6 of the above mentioned communicative behaviors were also looked for immediately before (2 minutes prior the start of feeding), during, and immediately after (two minutes after the end of the feeding) the feeding footage for each child. The mealtime communication scale allowed the researcher to analyze which communicative acts were most likely to occur specifically during mealtimes, or perhaps only were observable during feeding footage. The following definitions were used to identify each of the above- mentioned communicative acts looked for specifically during mealtime:

1.) *Looking*- infant looked at caregiver's face for at least 2 continuous seconds during bottle or spoon feeding

2.) *Engages*- infant smiled or vocalized and successfully gained attention of caregiver, engaging him or her in an interactive and reciprocal exchange during feeding

3.) *Responds*- infant responded to a communicative bid from caregiver during feeding, by smiling, turning when his or her name was called, vocalizing, or gesturing in response

4.) *Vocalizes during observed feeding footage*- infant made **any non-crying** soft, throaty, gurgling sounds; grunts, vowels, squeals or consonant sounds, raspberries, canonical syllables, or engaged in canonical babbling during mealtime

5.) *Imitation*- infant imitated or clearly attempted to imitate a sound, word, or gesture immediately following an adult model during observed feeding footage

6.) *Gestures*- infant produced nonverbal communicative bids with either hand and arm movements or whole body movements during feeding footage; only those nonverbal acts that appeared intentional and clearly served a communicative function were documented; infant was required to persist and to look and/or vocalize to the caregiver while doing the gesture to indicate signaling behavior, also caregiver had to react and respond to the communicative bid.

As with the Overall Early Communication “Red Flags” Scale, the individual items on the Mealtime Communication “Red Flags” Scale were totaled to result in a mealtime composite score. In addition to the infant behaviors observed to generate the mealtime communication composite score, caregiver responsiveness and engagement during feeding were also documented. A "Yes" or "No" was recorded for the statement, "*Caregiver talks to and/or gestures to the infant during feeding*". In addition, a "Yes" or "No" was recorded for the following statements, "*Caregiver is responsive to infant signals during feeding (stop/start/change position)*" and "*Caregiver reciprocates/responds to social bids by the infant (affect/emotion/smile).*" A global level of caregiver responsiveness and reciprocation during feeding footage was noted by checking one of the following: high (frequently responds to infant feeding cues), occasional, rarely/almost never, never.

Oral-motor Feeding Dysfunction Severity Rating Scale: Bottle Feeding. This scale was completed while watching the feeding footage, which was considered to be the two minutes prior to the first "bottle in" until two minutes after the end of any bottle feeding opportunities. On this scale, the coder looked for various oral motor and feeding skills and behaviors (e.g. whether or not the infant was observed to cough or choke while taking the bottle) and recorded "Yes or "No" to indicate whether or not the behavior occurred. There were 12 total items on this scale, and a total of all shaded circled items resulted in a composite score. Descriptive information was also recorded for the following: description of the infant's body position and support, information with regard to food types, and tools used during mealtime. The following feeding behaviors and oral-motor feeding skills or disorganized patterns indicating possible "red flags" of oral-motor feeding dysfunction were noted for presence or absence during bottle feeding footage:

1.) *Anticipatory mouth opening*- infant opened mouth in anticipation of bottle most of the time

2.) *Panic reactions*- infant observed to panic on presentation of or during bottle feeding, (e.g. eyes widening with increase in tension, gag, arching, pushing away)

3.) *Able to settle onto nipple and/or initiate sucking once in mouth*- infant was able to settle in and begin sucking without any delay in the sucking process once the bottle was introduced and the nipple was in the mouth

4.) *Seal observed*- no liquid loss and/or nipple not easily pulled out of mouth

5.) *More than intermittent liquid loss*- infant lost fluid constantly and throughout the feeding (more than 50% of the time)

6.) *Continuous or repeated audible sucks/clicks/swallows*- infant was heard making frequent swallowing sounds throughout the course of the feeding

7.) *Smooth rhythmic sequence to sucking*- infant was able to get into a rhythmic pattern of sucking with coordinated sucking bursts and integrated suck/swallow/breathe

8.) *Sustained sucking*- infant observed to do 4 or more sucks in a row, frequent sucking pauses not observed

9.) *Infant observed to work hard to breathe during feeding*- behaviors noted such as nostril flaring, use of accessory chest muscles as observed by noticeable chest expansion and retraction, head bobbing, infant stopping frequently to gasp for breath

10.) *Cough, choke or gag- infant observed to cough, choke or gag during the* bottle feeding footage

11.) *Multiple cough, choke, or gag*- infant observed to cough, choke, or gag more than once during the bottle feeding footage

12.) *Munch or chew on the nipple*- infant observed to munch or chew the nipple at the beginning or middle of the feeding

Oral-motor Feeding Dysfunction Severity Rating Scale: Spoon Feeding. This scale was completed while watching the feeding footage of spoon feeding infants during the two minutes prior to the first "spoon in" to two minutes after the mealtime ended. Again, a "Yes" or "No" was documented as to whether listed oral-motor feeding skills or disorganized feeding behaviors were observed. There were 11 total items on the scale, and a total of all shaded circled items resulted in the composite score. Descriptive information was also recorded for the following: description of the infant's body position and support, information with regard to food types, and tools used during mealtime. The following feeding behaviors and oral-motor feeding skills or disorganized patterns indicating possible "red flags" of oral-motor feeding dysfunction were noted for presence or absence during spoon feeding footage:

1.) *Anticipatory mouth opening*- infant opened mouth in anticipation of the spoon most of the time

2.) *Panic reactions*- infant observed to panic on presentation of or during spoon feeding, (e.g. eyes widening with increase in tension, gag, arching, pushing away)

3.) *Lips are active*- infant was observed to close upper and/or lower lips on spoon

4.) *More than intermittent food loss*- infant lost food from mouth constantly and throughout the feeding (more than 50% of the time)

5.) *Continuous or repeated audible sucks/clicks/swallows*- infant was heard making frequent swallowing sounds throughout the course of the spoon feeding

6.) *Smooth rhythmic sequence*- infant was able to get into a rhythmic pattern of sucking, chewing, or munching food from the spoon with coordinated and integrated swallowing and breathing

7.) *Infant observed to work hard to breathe during feeding*- behaviors noted such as nostril flaring, use of accessory chest muscles as observed by noticeable chest expansion and retraction, head bobbing, infant stopping frequently to gasp for breath

8.) *Cough, choke or gag*- infant observed to cough, choke or gag during the spoon feeding footage

9.) *Multiple cough, choke, or gag*- infant observed to cough, choke, or gag more than once during the spoon feeding footage

10.) *Consistent and considerable protrusion of tongue*- infant's tongue was often visible and was coming out of the mouth during most of the feeding

11.) *Suckle pattern instead of munch pattern observed in chewing*- infant observed to use extension-retraction of the tongue with opening and closing of the jaw in a rhythmical action; lips do not assist in removing food from spoon

The researcher-created scales were used to note the presence or absence of early communicative acts (e.g. vocalizations, preverbal communicative acts/early gestures) during feeding and non-feeding interactions, as well as oral-motor feeding skills or "red flags" of feeding problems (e.g. choking, coughing, liquid or food loss). For each of the four severity rating scales, "Overall Early Communication Red Flags Scale", "Mealtime Communication Red Flags Scale", "Oral Motor Feeding Dysfunction Severity Rating Scale: Bottle Feeding", and "Oral Motor Feeding Dysfunction Severity Rating Scale: Spoon Feeding" a composite score was generated. A higher composite score indicated less communicative behaviors or more dysfunctional oral-motor skills observed, therefore indicating a greater possibility of early communication or oral-motor feeding concerns.

Outcomes Measures

The Preschool Language Scale-4 (PLS-4, Zimmerman et al., 2002) is a standardized assessment of expressive and receptive language development in infants and young children ages birth to 7 years of age, and was used as the outcome variable in this study. The PLS-4 was standardized on over 1500 children ages 2 weeks to 6 years, including children with disabilities, and 39.1% of whom were minorities, representative of the U.S. population (15%, or n=232 of the standardization sample were African American). The PLS-4 was used in the original study at approximately 24 months of age, and was administered by a clinical psychologist. It assesses pre-linguistic skill, social communication, and language skills on two subscales of Expressive Communication and Auditory Comprehension (Zimmerman et al., 2002). The PLS-4 provides a standard score such that the mean is 100 and the standard deviation is 15 on each of the two subscales, as well as on the Total Language Score. Acceptable inter-rater, test-retest, and internal consistency reliability levels and concurrent validity are reported in the examiner's manual, with internal consistency coefficients ranging from .81 to .97. The PLS-4 assesses a relatively brief but balanced sample of language behaviors.

In addition to language scores at 2 years of age, cognitive test scores from the *Bayley Scales of Infant Development-II (BSID)* (Bayley, 1993) were also available to the researcher to examine the predictive relationship between the 6 month adjusted age data of communication "red flags" during feeding and nonfeeding interactions and later cognitive scores, and between oral-motor feeding skills and dysfunction "red flags" and later cognitive scores. Specifically, the BSID has two subscales, the Psychomotor Development Index (PDI) and Mental Development Index (MDI). The MDI score was of particular interest with regard to any relationship between predictor variables at 6 months and this outcome variable at 2 years of age, as this subscale encompasses language skills in the cognitive skills measured. The MDI specifically measures infant cognitive skills including memory, habituation, problem solving, classification, language, and social skills (Black & Matula, 1999).

Data Management

All of the data viewed for this dissertation research study were originally videotaped on camcorders by the MOMS study research assistants at home visits. Videotape footage was then burned onto CDs for computer coding and storage purposes. For the purposes of the current study, video interactions were viewed from copies of the original CDs in order to code communicative behaviors and oral-motor feeding skills of the infants, as well as gross level of caregiver interactive behaviors (gesturing or talking to infant) and caregiver ability to read and respond to infant social and feeding cues.

Coding for each of the 42 participant's 6 month adjusted age home videotapes was completed on the approximately 45 minutes of total footage for each child. The researcher watched each videotape that had been copied to CD format, using CD viewer computer software (Windows Media Player version 11.0). Although most of the original videotapes burned to the CDs had a timestamp, some did not, so the researcher kept track of the time when coded behaviors were observed by noting the time on the Windows Media Player time tracker.

Inter-Rater Reliability

Before coding the entire data set, one research assistant was recruited and trained to code for reliability purposes. The research assistant completed training that included reading and review of the coding manual, and multiple meetings with the investigator to watch videotape footage and observe examples of the communication and feeding behaviors to be coded. During these meetings the rules for coding were discussed and made clearer, if necessary, with examples for each code. After the initial training sessions were completed, the research assistant completed the independent coding of five training videos over a period of two weeks, and compared her results to the primary researcher's coding. This process was continued with two additional training videos until the research assistant was trained to 80% coding agreement with the investigator. During this initial training period, where there were disagreements due to lack of clarity between the coders the original coding system and coding manual were modified as necessary to clarify definitions and terms and the final criteria were determined. Once the final criteria and definitions were determined, all data were coded using the final version of the coding manual. After the research assistant completed the training and reached 80%

agreement with the investigator, she then coded twenty percent of the videotapes (8 of the 42 videotapes), which were randomly selected to be independently coded by the research assistant. After assuring reliability with the independent coder, the primary researcher coded the entire dataset.

Inter-rater reliability was also calculated using Cohen's kappa statistic (Cohen, 1960) as described by Bakeman & Gottman (1997). The kappa statistic is a measure of observer agreement that corrects for the proportion of agreement expected by chance (Cohen, 1960). Therefore, the kappa statistic is preferable to using only the proportion of agreement observed. The kappa statistic measure of agreement is scaled to be 0 when the amount of agreement is what would be expected to be observed by chance, and 1 when there is perfect agreement. Landis & Koch (1977) suggest the following interpretations of kappa coefficients: 0.00-0.20 slight agreement, 0.21-0.40 fair agreement, 0.41 –0.60 moderate agreement, 0.61-0.81 substantial agreement, 0.81-1.00 almost perfect agreement.

Inter-rater agreement estimates were calculated for 20% of the videotapes (8 total) coded independently by both the researcher and research assistant. The total composite scores for each of the Overall Early Communication, Mealtime Communication, and Oral-Motor Feeding (total combined composites for bottle and spoon feeding) scores were used in the inter-rater reliability kappa statistic analyses. Because two raters completed the reliability coding, and some of the responses on the coding sheets were conditional responses, weighted kappas were used in the SAS program (version 8.2). The weighted kappa coefficient is a generalization of the simple kappa statistic, using weights to quantify the relative difference between categories or in this case, categories of composite scores. For example, there were conditional responses or levels in the Overall Early Communication Scale with regard to vocalizations (e.g. If the infant vocalized, was the vocalization an instance of vocal play, canonical syllable, or canonical babbling). In addition, if a communicative behavior occurred during Mealtime Communication "Red Flags" coding, this behavior was also counted as an item on the Overall Early Communication "Red Flags" Scale (which documented the presence of communicative behavioral acts occurring anywhere in the videotape footage). Essentially, the weighted kappa statistic involved giving more weight to those reliability coding composite scores (e.g. composite scores generated from the researcher and reliability coder research assistant) that were closer to each other, and decreased weights to those scores that were further apart.

The summary of weighted kappa statistics is as follows: for Overall Early Communication composite scores, a kappa statistic of 0.5556 was obtained, suggesting moderate agreement as defined earlier by Landis & Koch (1977). Mealtime Communication composite scores generated a kappa statistic of 0.3571, suggesting fair agreement in inter-rater reliability for this measure. Oral-motor Feeding reliability composites generated a kappa statistic of 0.6818, suggesting substantial agreement for this measure. The average of the kappa statistics across all three predictor variables was therefore 0.5315; according to the criteria proposed by Landis and Koch (1977), this value represents at least moderate agreement beyond what would be expected by chance. A point by point agreement was also calculated to determine reliability for each coded behavior on each scale that was totaled to get the composite score for that predictor variable (early communication, mealtime communication, and oral-motor feeding dysfunction). Point by point agreement has been defined as agreement estimated for two observers by directly comparing judgments for each recording opportunity (Cordes, 1994). An opportunity may thus result in an agreement if both observers scored the trial in the same way, or a disagreement if it was scored differently. The agreement index is calculated by dividing the total number of agreements by the total number of agreements plus disagreements and multiplying by 100 to gain a percent. For the Overall Early Communication composite score there was an 82% agreement (92 out of 112 total possible agreements). For the Mealtime Communication composite score scale there was a 75.8% agreement (50/66 total possible agreements). For Oral-Motor Feeding scales there was an 80% agreement (72/90 total possible agreements).

CHAPTER 4

RESULTS

The primary aims of this research study were to investigate whether specific "red flags" of communicative behaviors observed during feeding and non-feeding interactions and of oral-motor feeding skills of premature infants at 6 months adjusted age were predictive of later speech and language abilities as measured by standardized assessments at 24 months of age. Specifically, communicative behavioral acts before, during, and after a mealtime and infant oral-motor feeding skills during bottle or spoon feeding were coded from home video footage from an existing data set of premature African American infants and their caregivers. It was of particular interest during feeding and nonfeeding interactions to note the presence or absence of early communicative acts (e.g. vocalizations, preverbal communicative acts/early gestures) and to view their absence as potential "red flags" as well as oral-motor feeding skills or "red flags" of feeding difficulties (e.g. choking, coughing, liquid or food loss). In addition, risk variables that were present prior to discharge as well as the overall caregiver contingent responsivity of the caregivers were analyzed to determine whether they might be predictive of later language skills.

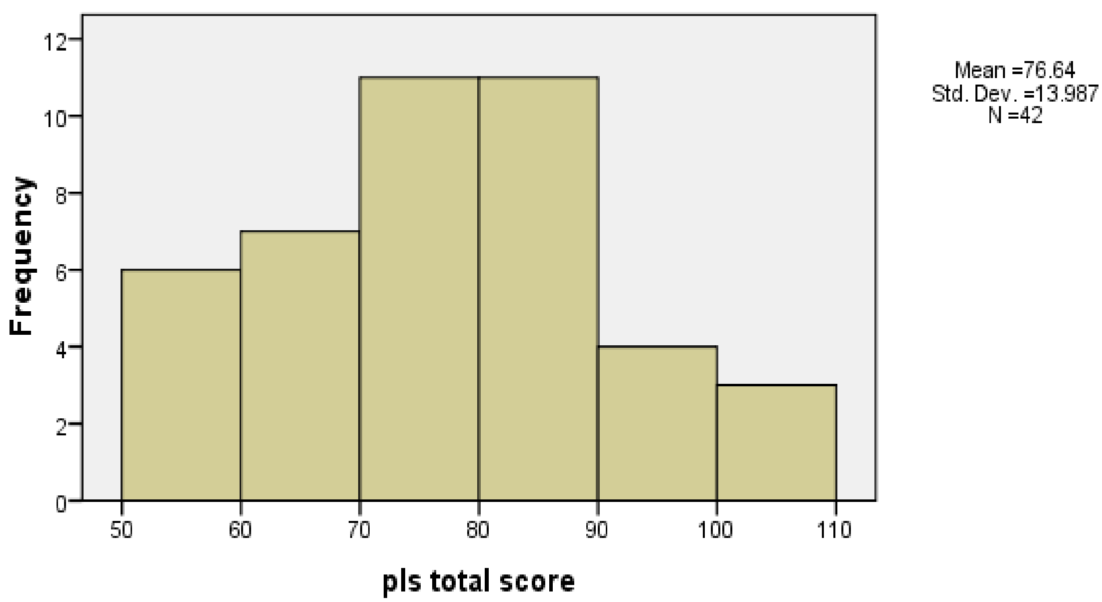
Two data analytic strategies were employed in this study. The results of the descriptive analyses are presented first. Following the descriptive information, the specific research questions and data that resulted from the regression analyses used to answer the research questions will be described. Unless otherwise noted, all statistical analyses were completed using SPSS (version 16.0)

Descriptive Statistics for Outcome Variables

As a preliminary step in examining the data, descriptive statistics were obtained for all variables of interest related to the predictor variables that were the composite scores of oral-motor feeding skills, early communication, and mealtime communication, as well as outcome variables such as Preschool Language Scale-4 (Zimmerman et al., 2002) scores. Additionally, descriptive statistics also were obtained for caregiver information such as overall responsiveness to infant communicative bids and feeding cues, and whether caregivers spoke and/or gestured to infants during feeding and non-feeding interactions. Prior to analyses, outcome data were examined for normality by observing histograms in SPSS, which documented a normal bell shaped curve to the distribution of the PLS-4 scores.

Table 4.1

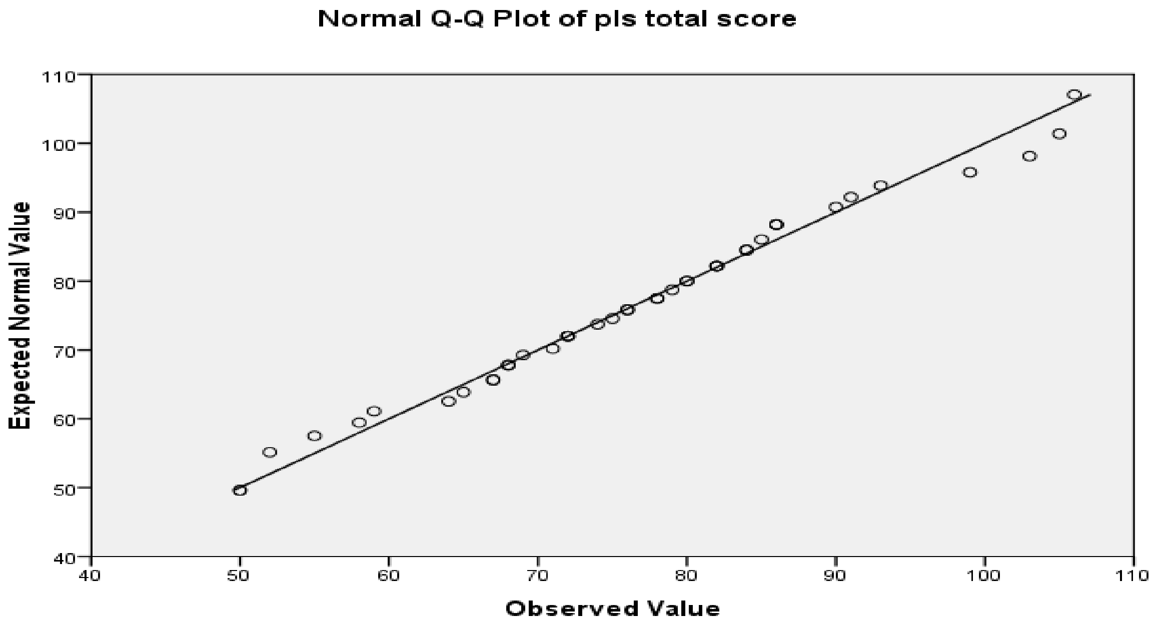
SPSS Histogram of Current Study Participants' Preschool Language Scale-4 Scores



As can be seen in Table 4.1, while the PLS-4 scores can be represented in a normal bell shaped curve, these data were somewhat skewed, with more children in the study sample scoring at the lower range of PLS-4 scores than in the higher end. It should be noted that the mean score on this language measure is 100 with a standard deviation of 15; therefore, the study participant's group mean of 76.64 is -1.5 standard deviations from the standard score mean. SPSS reported the type of distribution for the histogram as "normal", but to further examine the outcome data, a Q-Q plot was also observed in SPSS, as can be seen in Table 4.2. The normal Q-Q chart plots the values seen in the dataset (dots along the line) against the values you would expect to get if the distribution were normal (expected values represented by the straight line). If the data are normally distributed, then the observed values should fall exactly along the straight line (Field, 2005); therefore the outcome data as observed in Table 4.2 do show some minor deviations from normality.

Table 4.2

Q-Q Plots Generated by SPSS Showing PLS-4 Score Distribution



Due to the fact that all data points in Table 4.2 did not fall exactly on the line, indicating some deviations from normality, another way of looking at the data was employed in SPSS. The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to compare the scores in the sample to a normally distributed set of scores with the same mean and standard deviation. The null hypotheses for both of these tests are that the dependent variable is normally distributed in the population. If these tests are non-significant ($p>.05$) the null is retained, suggesting that the assumption is correct, and that the distribution of the sample is not significantly different from a normal distribution (Field, 2005). In other words, if these tests are non-significant, the data are probably normal. Table 4.3 provides this output from SPSS, with “df” signifying “degrees of freedom” and “Sig” standing for “significance level”.

Table 4.3

Tests to Determine Normality of Outcome Data

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
pls total score	0.085	42	.200*	0.979	42	0.616

a. Lilliefors Significance Correction
*. This is a lower bound of the true significance.

The above findings are important because they explain that the sample is in fact normally distributed with statistical significance, thus assuring that the assumption of normality has been met and the data can be used in further parametric tests. While these data were normally distributed, it should be recalled that the mean PLS-4 score for this group of children was a 76.74; a score of 77 is -1.5 standard deviations from the mean of children in the standardization sample for this assessment tool (Zimmerman et al., 2002). Therefore, this sample of premature infants, as a whole, had a group mean that indicated much lower overall scores on this standardized language assessment than would be expected from other infants of the same age within the general population. In fact, only three children scored above 100. Table 4.4 documents the mean, standard deviation, and range of PLS-4 scores for the study participants on the outcome variable of Total Language Score, as well as the two subtest scores of Auditory Comprehension and Expressive Communication.

Table 4.4

Descriptive Statistics for Preschool Language Scale Scores

	Mean	SD	Range
*PLS-4 Total Language Score	76.64	13.99	50-106
Auditory Comprehension (AC) Subtest	76.71	12.73	50-106
Expressive Communication (EC) Subtest	80.86	13.86	55-111

*Preschool Language Scale, 4th Edition (Zimmerman, et al, 2002)

In addition to examining the outcome data for the current study sample, outcome data also were compared with those from the original 177 MOMS study participants to investigate whether this subsample was significantly different from the larger sample. T-tests examining variables such as infant gestational age, birth weight, gender, and days on mechanical ventilation revealed no significant differences between the current study subsample and the larger group. In addition, t-tests of maternal variables such maternal age and education level in years also found no significant differences, as can be noted in Table 4.5. In summary, Table 4.5 documents that there were no statistically significant differences between the original 177 MOMS study participants and the 42 participants in the current study.

Table 4.5

Comparison of Current Study and MOMS Study Participants

	Current Study		MOMS Study		Test Stat.	Independent		
	Mean	Std.	Mean	Std.	Dist.	Test Stat	DF	P (2 tailed)
Gestational Age (Weeks)	28.1	2.9	28.3	2.9	t	0.4	41	0.68991048
Birth Weight (Grams)	1024	383	1106	394	t	1.24	41	0.221848307
Sex of Child: Male	0.38	0.07	0.43	0.04	z	0.57	NA	0.958521537
Ventilation (Days)	18.95	22.8	15.5	26.5	t	0.85	41	0.398419076
Maternal Age	26.3	6.7	25.9	6.5	t	0.35	41	0.728268725
Maternal Education (Years)	12.8	1.7	12.6	1.8	t	0.68	41	0.501820525
N	42		177					

Analyses of Research Questions

In order to address each research question in depth, several statistical procedures were necessary. The results of the current investigation are described in the following sections, with reference to each research question.

Research Question 1: Relationship of Early Communicative Behaviors During Feeding and Nonfeeding to Later Speech and Language Skills. The main purpose of the first research question was to analyze whether early "red flags" of possible communication delays during feeding and non-feeding interactions of premature infants at 6 months adjusted age predicted deficits of later speech and language skills at 2 years of age. It was hypothesized that early communicative behavioral acts during both non-feeding and feeding interactions at 6 months adjusted age in premature infants would predict later speech and language skills at 2 years of age as documented on the PLS-4 (Zimmerman et al., 2002). It was also of interest to determine which aspects of early communicative behaviors in preterm infants had greatest predictive value for later speech and language skills as measured by the Total Language score of the PLS-4. In addition, it was believed to be important to note which aspects of early communicative behaviors were most predictive of Expressive Communication and Auditory Comprehension subscale scores on the PLS-4 at 2 years of age.

Current Study 6 Month Adjusted Age Infant Predictor Variables

Predictor variables for data collected at 6 months adjusted age included the composite scores for each of the three coded areas of “red flags”, with the following possible range of scores on each, and higher scores being more indicative of possible difficulties in each area: Overall Early Communication Composite Scores (across entire videotaped footage) could have ranged from 0 (all possible types of communicative behaviors observed) to 9 (no infant communicative acts observed, thus many “red flags”), and similarly Mealtime Communication Composite Scores could range from 0-6. The Oral-Motor Feeding Skills and Difficulties- Combined Composite Score (for all participants, bottle and spoon feeding) had a possible range of scores of 0 (no “red flag” behaviors observed) to 11 (all “red flag” feeding difficulty behaviors observed).

Table 4.6

Descriptive Statistics for Predictor Variables Composite Scores

	Mean	**SD**	**Actual Range**	**Possible Range**
Early Communication “Red Flags”	2.76	1.819	0-6	0-9
Mealtime Communication “Red Flags”	2.71	1.486	0-6	0-6
Combined Oral-Motor Feeding Skills "Red Flags"	2.81	2.391	0-8	0-11

Regression Analyses

Linear regression analyses were completed to look at relationships between predictor/independent variables of Overall Early Communication and Mealtime Communication “Red Flags” Composite Scores coded from the 6 months adjusted age videotape footage and the criterion/dependent variable of *PLS-4* scores at 2 years of age. The regression analyses were first run with all predictor variables in the equation, and then were run again separately to look for any significant differences. Regression analyses revealed a highly significant negative predictive value of the Mealtime Communication “Red Flags” Composite Scores, with R squared= .155, F (1,41)=7.322, p= .01 as shown in Table 4.7. Children who were observed to use less communicative behaviors during mealtimes at 6 months adjusted age had lower PLS-4 scores at 2 years of age.

Table 4.7

Summary of Linear Regression Analysis for Mealtime Communication Predicting PLS-4

Variable	B	SE B	Sig.
MC Score	-3.702*	1.368	.010

Note. R2 = .155. *p<.05 **p<.01.

Mealtime Communication composite scores explained 15.5% of the variance in the PLS-4 scores at 2 years of age. Specifically, results from this regression indicated that for every increase of one point in the mealtime communication “red flags” composite score, PLS-4 scores decreased by 3.7 points. In other words, as the infant demonstrated fewer mealtime communicative behaviors resulting in a higher “red flags” composite score at 6 months adjusted age, the Total Language PLS-4 score at 2 years of age was found to be lower. When considering the separate PLS-4 subtest scores in further regressions, however, Mealtime Communication “Red Flags” Composite Scores were found to be significantly predictive of Expressive Communication subtest scores ($p=.008$), but were not found to be predictive of Auditory Comprehension subtest scores. This information suggests that the Mealtime Communication “red flags” Composite may be significantly related to later expressive language, but not necessarily to later receptive language skills in this group of African American premature infants.

To examine whether Mealtime Communication “Red Flags” Composite Scores were also sensitive predictors of other types of developmental outcome skills, these scores were further examined with regard to relationships between other available outcome data for these participants. Each infant in this study had information available from the Bayley Scales of Infant Development, Second Edition (Bayley, 1993), a cognitive assessment that included language items in the subscale. These scales include both a Physical Development Index (PDI) and a Mental Development Index (MDI). Therefore, since Mealtime Communication composites were significant predictors of PLS-4 (Zimmerman et al., 2002) language scores at 2 years of age, further regressions were run to determine whether these scores were also predictive of cognitive scores at two years of age. In keeping with the previous results, Mealtime Communication “Red Flags” Composite Scores were found to have a significant relationship with the infants’ Bayley MDI scores, as regression analyses revealed high significance ($p=.007$). Specifically, a negative relationship was found, with each 1 point increase on the Mealtime Communication “Red Flags” Composite Score at 6 months adjusted age resulting in a 5.279 points decrease on the Bayley MDI subscale at 2 years.

For each communicative act noted for its presence or absence during feeding and nonfeeding interactions, the coder documented whether the behavior was observed (e.g. infant gestured) as well as whether the behavior was observed more than once. Interestingly, the item on the Mealtime Communication composite, "infant looks at caregiver during feeding" was not significantly predictive (p= .707) of PLS-4 scores on it's own; however, whether or not the infant looked at the caregiver more than once during the feeding was significantly predictive of PLS-4 scores (p= .019). In addition, the item on the composite, "infant responds to caregiver during feeding" was also not significantly predictive (p=.17) of later PLS-4 scores; yet the infant responding to the caregiver more than once during the feeding was significant (p=.049).

Although communication specific to the period before, during, and immediately after mealtime was significant, the Overall Early Communication "Red Flags" Composite Scores generated from observing infant communication over the course of the entire videotaped footage were not found to be significantly predictive of PLS-4 scores at 2 years of age (p= .181). As expected based on the above results, the results of further regression analyses were also not significant for predictive relationships between these composite scores and PLS-4 Auditory Comprehension and Expressive Communication subtest scores. Whether any of the communicative behaviors occurred more than once during the footage was also not significant for almost all items with regard to a relationship with later PLS-4 total scores or subtest scores; the only exception to this was the presence of repeated instances of vocal play. The observation of the infant engaging in vocal play more than once during the observed footage was significant (p= .018) when run in a regression with the Expressive Communication subtest of the PLS-4.

While most of the items on the Overall Early Communication and Mealtime Communication Composites were not significant predictors of later PLS-4 scores in and of themselves, for descriptive purposes it is of interest to note the percentage of infants who engaged in these communicative behaviors during feeding and nonfeeding footage. Table 4.8 on the following page provides the percentages of infants who engaged in each of the communicative behaviors during all of the observed footage, and documents the percentages of those who were observed to produce these communicative behaviors more than once.

Table 4.8

Overall Early Communication Behaviors Observed for all Participants (n=42)

Overall Communication Behaviors	% of Infants Displaying Behavior	% of Infants Displaying Behavior More Than Once
Looks at caregiver's face	100%	93%
Engages caregiver in interaction	76%	36%
Responds to caregiver	86%	69%
Vocalizes	100%	98%
Displays Vocal Play	76%	62%
Displays Marginal Babble	57%	45%
Displays Canonical Babble	41%	31%
Imitates caregiver action or vocalization	33%	14%
Gestures communicatively	50%	31%

Table 4.9 on the following page provides the percentages of infants who engaged in each of the communicative behaviors during observed mealtime footage, and documents the percentages of the infants who were documented to produce communicative behaviors more than once during feeding.

Table 4.9

Mealtime Communication Behaviors Observed for all Participants (n=42)

Mealtime Communication Behaviors	% of Infants Displaying Behavior	% of Infants Displaying Behavior More Than Once
Looks at Caregiver During Feeding	88%	67%
Engages Caregiver During Feeding	45%	12%
Responds to Caregiver During Feeding	48%	29%
Vocalizes During Feeding	81%	74%
Imitates an Action During Feeding	19%	5%
Gestures During Feeding	38%	9%

Research Question 1A: What aspects of early communicative behaviors (e.g. vocalizing acts, early pre-gestural acts) at 6 months adjusted age had the greatest predictive value for later speech and language skills in preterm infants?

Analyses were conducted to determine which aspects of the early communicative behaviors coded in this study had greatest predictive value for later speech and language skills. As stated earlier, although communication specific to the period before, during, and immediately after mealtime was significantly predictive of total language scores on the PLS-4 (Zimmerman et al., 2002), the Overall Early Communication "Red Flags" Composite Scores generated from observing infant communication over the course of the entire videotaped footage were not found to be significantly predictive of PLS-4 scores at 2 years of age (p= .181). No single behavior from the Overall Early Communication "Red Flags" Severity Rating Scale was found to be significant when isolated and run alone in the regression with PLS-4 (Zimmerman et al., 2002) scores. In addition, no single behavior from the Mealtime Communication "Red Flags" Severity Rating Scale was found to be significant when isolated and run alone in the regression with PLS-4 scores. However, one item “using a gesture during mealtime” was close to reaching significance (p=.099).

Research Question 1B: What aspects of early communicative behaviors at 6 months adjusted age were the most predictive of Expressive Communication and Auditory Comprehension subscale scores on the PLS-4 (Zimmerman et al., 2002) at 2 years of age?

As expected based on the results mentioned above, the results of further regression analyses were also not significant for predictive relationships between these composite scores and PLS-4 Auditory Comprehension and Expressive Communication subtest scores. Whether any of the communicative behaviors occurred more than once during the footage was also not significant for almost all items with regard to a relationship with later PLS-4 total scores or subtest scores; the only exception to this was the presence of repeated instances of vocal play. The observation of the infant engaging in vocal play more than once during the observed footage was significant (p= .018) when run in a regression with the Expressive Communication subtest of the PLS-4.

Research Question 2: Relationships Between Early Oral-Motor Feeding Skills and Later Speech and Language Skills

The main purpose of the second research question was to identify whether “red flags” of oral-motor feeding difficulties in premature infants at 6 months adjusted age predicted later speech and language skills as demonstrated on the PLS-4 (Zimmerman et al., 2002) at 2 years of age. It was hypothesized that “red flags” of oral-motor feeding difficulties at 6 months adjusted age in preterm infants would be predictive of later speech and language skills at 2 years of age. It was also of interest to determine which aspects of early oral-motor feeding skills at 6 months were most predictive of later speech and language skills on the PLS-4 at 2 years of age, and to examine which aspects of early oral-motor feeding skills at 6 months of age were most predictive of Expressive Communication and Auditory Comprehension subscale scores on the PLS-4.

Regression Analyses

Linear regression analyses were completed to look for relationships between predictor/independent variables of Oral-Motor Feeding Dysfunction "Red Flags" Composite Scores coded from the 6 months adjusted age videotape footage and the criterion/dependent variable of PLS-4 scores at two years of age. The Oral Motor Feeding Dysfunction Composite Scores as a whole were not found to be predictive of PLS-4 scores at 2 years of age. In addition, regression analyses determined that Oral Motor Feeding Dysfunction Composite Scores were also not significant with relation to Expressive Communication and Auditory Comprehension subscale scores on the PLS-4.

Bottle vs. spoon feeding participants. Although not a major focus of the current study, the question could be asked as to whether there were differences between the infants who were spoon fed and those who were bottle fed. The 42 participants could be divided into two groups, as they were coded in this category based on whether they were spoon feeders (n=21) or bottle feeders (n=21). Additionally, it should also be noted that in this study bottle feeding infants (21/42) were smaller than their spoon feeding counterparts, and this difference in birthweights also may have contributed to differences observed in the oral-motor feeding skills of these infants. Whereas the bottle feeding infants had a mean birthweight of 961 grams (SD=73) with a range of birthweights of

557-1680 (median=890), participants in the spoon feeding group had a mean birthweight of 1086 grams (SD=92) with a range of birthweights of 492-2110 (median=990). Therefore, separate regression analyses were conducted to determine whether the Oral Motor Feeding Composite Scores for spoon or bottle feeding participants had predictive relationships with PLS-4 (Zimmerman et al, 2002) total scores. Neither of these separate analyses revealed significant predictive relationships between these composite scores and later PLS-4 scores.

Further analyses were conducted to determine whether certain items on the bottle and spoon feeding composites were more sensitive than others in predicting later PLS-4 scores. The Oral-Motor Feeding Dyfunction Severity Rating Scale for *bottle feeding* did not have individual composite items which were found to be significant predictors of the PLS-4 on their own. However, the item “munch or chew of nipple observed at start or middle of feeding” was significantly predictive of PLS-4 Auditory Comprehension subscale scores ($p = .046$). This item predicted a decrease of 12.63 points on the PLS-4 AC subscale. In addition, this item approached significance in terms of predicting the Expressive Communication subscale of the PLS-4 ($p = .064$).

While most of the items on the Oral Motor Feeding Dysfunction Composites were not significant predictors of later PLS-4 scores in and of themselves, for descriptive purposes it is of interest to note the percentage of infants who were documented to exhibit feeding difficulties based on the individual items on this “Red Flags” scale. For example, the current study indicated that most infants were engaging in oral motor behaviors such as consistently opening the mouth for the approaching spoon by approximately 6 months adjusted age. All participants in the current study were observed to open their mouths in anticipation of the approaching bottle or spoon. However, the infants in this study also demonstrated some feeding difficulties. For example, only 57% of the bottle feeding infants in the current study were observed to have a smooth, rhythmic sequence to sucking. Mathisen et al (2000) reported similar results, with 56% of their 20 extremely low birthweight (ELBW) premature infants observed to have a smooth, rhythmic sequence to sucking.

Table 4.10 provides the percentages of infants who demonstrated individual oral-motor feeding skills and those who struggled with particular bottle feeding items.

Table 4.10

Oral Motor Feeding Skills and Difficulties - Bottle Feeding Subjects (N=21)

Bottle Feeding Behaviors	% Observed-Skill	% Observed-Difficulty
Anticipatory Mouth Opening	100%	
Panic Reactions Observed		5%
Able to Settle onto Nipple and Suck	50%	
Seal Observed	45%	
Significant Liquid Loss		36%
Continuous Audible Swallows		46%
Smooth Rhythmic Sequence to Sucking	57%	
Working Hard to Breathe		18%
Cough, Choke, Gag		32%
Multiple Cough, Choke, Gag		18%
Munch or Chew of Nipple		41%

Table 4.11 provides the percentages of infants who demonstrated specific oral-motor feeding skills and those who struggled with particular spoon feeding items.

Table 4.11

Oral Motor Feeding Skills and Difficulties - Spoon Feeding Subjects (N=21)

Spoon Feeding Behaviors	% Observed-Skill	% Observed-Difficulty
Anticipatory Mouth Opening	95%	
Panic Reactions Observed		19%
Lips Active	95%	
Food Loss Most of Meal		38%
Audible Swallows		0%
Smooth, Rhythmic Sequence	95%	
Working Hard to Breathe		10%
Cough, Choke, Gag		29%
Multiple Cough, Choke, Gag		19%
Tongue Protrusion Observed		24%
Suckle Pattern Observed		24%

The only spoon feeding items that were predictive of later PLS-4 scores were "infant coughs, chokes, or gags during feeding" (p=.027), and "infant coughs, chokes, or gags more than once during feeding" (p=.048). However, these items had positive coefficients, which indicated that the more infants coughed, choked, or gagged during spoon feeding at 6 months adjusted age, the higher their PLS-4 scores were at 2 years of age. It should be noted, however, that when the three highly influential outliers (who scored more than 2 deviations above the group mean) were removed from the model, these items became nonsignificant. The presence of these influential outliers and their impact on the results will be explored in depth in a section to follow.

Research Question 3: Relationships of Early Influences Prior to Discharge from the Hospital and Caregiver Contingent Responsivity to Later Language Skills

Research Question 3A: Which early indicators of possible developmental delays as recorded prior to hospital discharge had predictive value for later language scores in this group of premature infants?

The results presented below in the following section focus on the preliminary analyses conducted to determine whether factors such as gender, birth weight, gestational age, Neurobiological Risk Scores (NBRS, Brazy et al., 1991), and length of mechanical ventilation and total hospital stay in days might have influenced the outcome measures within this group of African American premature infants. The following section therefore outlines the predictive relationships between those data that were collected at birth and at discharge from the hospital with regard to relationships between these early infant variables and later Preschool Language Scale-4 scores (Zimmerman et al., 2002).

*Gender***.** Due to the potential for gender differences in premature infants it was important to look for any differences in the outcomes that may be attributed to possible gender influences. In this study sample there were more females than males, with 26 of the 42 subjects being girls, and 16 boys. In regression analyses, gender alone was not found to be a significant predictor of the PLS-4 (Zimmerman et al., 2002) scores at 2 years of age (p=.478). Based on these findings, gender was excluded from the statistical model and was not assumed to play a significant role in the results reported in the section to follow.

Birthweight. Regression analyses revealed that infant weight at birth was a statistically significant predictor of PLS-4 scores at 2 years of age (p=.013), with birthweight accounting alone for 14.4% of the variance when entered into the regression with PLS-4 scores.

Gestational age. Gestational age in weeks at the time of birth was not found to be a significant predictor of PLS-4 scores at 2 years of age (p=.060) when this relationship was examined in regression analyses.

Neurobiological Risk Scores (NBRS). NBRS scores recorded during each infant's hospitalization in the NICU were found to be highly predictive of PLS-4 scores at 2 years of age (p=.008), with NBRS scores alone accounting for 16.7% of the variance.

Days on mechanical ventilation. The total number of days that the infant was on a ventilator in the NICU was predictive of PLS-4 scores at 2 years of age (p= .005), with days on mechanical ventilation alone accounting for 18% of the variance.

Length of hospital stay. The total number of days that the infant was hospitalized after being born prematurely was highly predictive of PLS-4 scores at 2 years of age (p= .001). Total length of hospital stay in days accounted for 27.6% of the variance when entered into the regression alone with PLS-4 scores.

Research Question 3B: Does global level of caregiver responsiveness during both feeding and nonfeeding interactions at 6 months adjusted age predict infant language and cognitive scores at 2 years of age?

In the current study maternal age and education were not found to be significant predictors of PLS-4 (Zimmerman et al., 2002) scores at 2 years of age. Based on these findings, these variables were excluded from the statistical model and were not assumed to play a significant role in any of the following analyses or results.

Caregiver information that was included in the statistical model for research question 3B included whether the mother initiated or responded to the infant during feeding and nonfeeding footage. For each participant in this study, caregiver information that was documented included the following: whether the caregiver talked or gestured to the infant or reciprocated infant bids to engage in social interaction, and global levels of overall caregiver engagement and reciprocation were rated during both feeding and non-feeding interactions. Caregiver responsivity overall was high, with 41/42 mothers (97.6%) noted to talk and/or gesture to their infant, respond to the infant's communicative bids (such as responding to the infant fuss, cry, or gesture) and reciprocate to the infant's social bids (such as with shared affect, emotion, or smile). Caregiver responsivity was somewhat lower during mealtimes. These percentages included 37/42 (88.1%) of the mothers noted to talk to the infant during feeding, 40/42 (95.2%) of mothers noted to be responsive to infant signals during feeding (e.g. stop/start/change position), and 38/42 (90.5%) of mothers noted to reciprocate to social bids by the infant during mealtime.

The caregiver items listed above on the Overall Early Communication "Red Flags" Severity Rating Scale were used to document caregiver responsiveness over all the interactive footage, whereas the Mealtime Communication "Red Flags" Severity Rating Scale items captured caregiver overall responsiveness surrounding feeding. Table 4.12 documents the percentages of mothers who were noted to respond or reciprocate to infant communicative bids at levels of "high", "occasional", and "rarely/almost never" in terms of global responsiveness over the whole 45 minutes of videotaped footage, as well as during feeding.

Table 4.12

Early Communication and Mealtime Communication: Caregiver Global Responsiveness

Overall Early Communication (All footage)	Number of Mothers	Percent of Total Mothers	Mealtime Communication (feeding)	Number of Mothers	Percent of Total Mothers
High	28	66.7	High	28	66.7
Occasional	9	21.4	Occasional	8	19.0
Rarely/Almost never	5	11.9	Rarely/Almost never	6	14.3
Total	42	100	Total	42	100

It should be noted that none of the caregivers were coded as "never" responding or reciprocating infant communicative bids on any of the observed video footage, therefore, these data were entered into the database as: high responsiveness= 0, occasional responsiveness= 1, rarely/almost never respond= 2 (with higher numbers indicating low responsivity).

Regression analyses revealed that for both feeding and non-feeding footage, global levels of caregiver responsiveness at 6 months adjusted age for the infants were found to be significant predictors of later infant PLS-4 (Zimmerman et al., 2002) scores at 2 years of age. Table 4.13 provides the regression results of the caregiver global level of overall responsiveness as it relates to later language scores; essentially, the less responsive the mother was at 6 months adjusted age, the lower the child's PLS-4 score was by 7.2 points. These results indicate that more responsive mothers throughout all videotaped footage at 6 months had children who performed better on this language measure at 2 years of age.

Table 4.13

Early Communication- Caregiver Overall Global Responsiveness Predicts PLS-4

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	79.907	2.426		32.932	.000
	EC global level	-7.215	2.920	-.364	-2.471	.018

a. Dependent Variable: pls total score

Table 4.14 provides information with regard to the relationship between global level of caregiver communication specifically during mealtimes and later language scores. Caregiver global responsiveness during feeding interactions was also coded similarly to overall communication, with high caregiver responsiveness during feeding= 0, occasional responsiveness= 1, rarely/almost never respond= 2. As can be seen in the following table, the less responsive the caregiver was during feeding interactions at 6 months adjusted age, the lower the infant's PLS-4 score was at 2 years by about 6 points.

Table 4.14

Mealtime Communication- Caregiver Responsiveness During Feeding Predicts PLS-4

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	79.521	2.470		32.192	.000
	fdg global level	-6.044	2.830	-.320	-2.136	.039

a. Dependent Variable: pls total score

The Effects of Outliers

As stated earlier, the Overall Early Communication and Oral-Motor Scales were not predictive of PLS-4 (Zimmerman et al, 2002) scores. These results were impacted by the presence in the sample of 2 outliers (subject #'s 4 and 215). These children had PLS-4 scores that were more than 2 standard deviations above the group mean; while the group mean for the PLS was 76 these children scored 104 and 106, respectively. While these two children both had very high Overall Early Communication and Oral-Motor Feeding "Red Flags" Composite Scores at 6 months of age (thus indicating more oral-motor feeding dysfunction and decreased communicative behavioral acts), they also had the highest PLS-4 scores at 2 years of age, contradicting the original hypotheses that decreased communication and increased oral motor dysfunction at 6 months would be related to diminished language scores at 2 years of age. In addition, a third subject was also found to be a significantly "influential" data point in the analyses (subject #66). This participant was also considered to be an "outlier" on the PLS-4 (having a PLS-4 score of 103, almost 2 standard deviations above the group mean) but unlike the other two high scorers did very well on early communication, mealtime communication, and oral-motor feeding skills at 6 months adjusted age. Thus, this infant supported the original hypotheses of good early oral motor feeding and communication skills leading to higher PLS-4 scores. When these three most influential subjects were removed from the dataset and regressions were run again, composite scores that were originally non-significant predictors of later PLS-4 (Zimmerman et al, 2002) scores became statistically significant. For example, the Overall Early Communication "Red Flags" severity rating scale composite went from a $p= .181$ to a $p= .046$.

Summary of Statistical Analyses

In this sample of premature African American infants and their caregivers, regression analyses employed for this study documented the presence of a significant predictive relationship between Mealtime Communication "Red Flags" Composite Scores at six months adjusted age and later Total Language PLS-4 scores. In addition, there was also a predictive relationship between these composite scores at 6 months adjusted age and the Expressive Communication subtest scores of the PLS-4 at 2 years of age. A similar relationship was documented between the Mealtime Communication Composite Scores and Bayley Scales of Infant Development- Mental Development Index (Bayley, 1993) data at 2 years for this sample of African American premature infants. In contrast, neither the Overall Early Communication "Red Flags" Composites Scores nor the Oral-Motor Feeding Dysfunction "Red Flags" Composite Scores was found to be significantly related to later PLS-4 scores. These composite scores did not predict EC or AC subtest scores on the PLS-4, and the majority of all separate composite items were not significant in predicting later language scores. The few items that appeared to be sensitive in predicting PLS-4 scores were somewhat perplexing (e.g. cough/choke/gag on spoon feeding at 6 months adjusted age led to lower PLS scores at 2 years), and were not significant when three highly influential outliers were removed from the statistical model.

Regression analyses also documented the presence of a significant relationship between global levels of caregiver responsiveness (both during the entire videotaped footage as well as specifically during mealtime) at 6 months adjusted age and infant language scores at 2 years of age. Specifically, infants with more responsive caregivers during both feeding and nonfeeding interactions at 6 months adjusted age scored significantly higher on the PLS-4 (Zimmerman et al., 2002) at 2 years of age.

CHAPTER V

DISCUSSION

The purpose of this study was to investigate whether oral-motor feeding skills and communicative behaviors observed during feeding interactions between 6 month old formerly premature infants and their caregivers were predictive of later speech and language abilities as measured by standardized assessments at 24 months of age. Communicative behaviors during nonfeeding interactions were also examined at 6 months adjusted age and considered within this group of African American premature infants in terms of a possible relationship between these early overall communicative behaviors and later language scores. To the author's knowledge, there have been few studies examining these specific relationships. However, it continues to be suggested that feeding is a "pre-speech skill" (Morris & Klein, 1987; 2000). Given that early feeding difficulties may set the infant on an altered trajectory for communication interactions as well as speech and language skills, and that premature infants are at risk for delays and disorders in these areas that persist into school age and beyond, the potential benefit in delineating such a relationship could result in earlier identification of problems and appropriate interventions with infants and families. In addition, risk factors present at discharge and overall caregiver responsivity at six months were examined as potential predictors of language outcomes.

There were two main focal points of the current study: determining the influence of early oral motor feeding difficulties on later language skills/scores, and identifying whether the presence or absence of communicative behavioral acts during both feeding and nonfeeding interactions at 6 months adjusted age in this group of premature African American infants predicted language at 2 years of age. The discussion that follows summarizes the current study findings and relates them to previous research. Implications for further research and clinical practice are also presented. Finally, study limitations are addressed and directions for future research in the area of infant feeding skills and correlations with later speech and language skills are delineated.

Current Study Findings as Related to Previous Research

Outcome Data

Despite the fact that the PLS-4 (Zimmerman et al., 2002) outcome data were normally distributed in the current study sample, it is of interest to note that the mean PLS-4 score for this group of children was a 76.74, 1.5 standard deviations from the mean score of 100 for children in the standardization sample. In addition, the larger overall original sample of MOMS study participants also had lower than expected PLS-4 scores at 2 years of age; of the 124 original subjects from the MOMS project who had PLS-4 scores at 2 years, the group mean was 77.6, still almost 1.5 deviations from the mean in the standardization sample. When the current study sample is considered within the context of the larger MOMS sample, these low PLS-4 scores provide even stronger evidence that for this sample of African American premature infants the risk of language delays into the preschool years was evident. Therefore, the current study participants mean scores represent a group of children for whom the PLS-4 scores at 2 years of age were significantly lower than expected as compared to the overall population. The research literature is divided as to whether very low birthweight (VLBW) premature infants exhibit later delays in speech and language skills (Aram et al., 1991; Jennische & Sedin, 1999; Magill-Evans & Harrison, 1999). The current study outcome data seem to suggest that in this small sample of African American rural premature infants there was a definite risk for later language delays. Such delays could possibly set these African American premature infants on an altered trajectory for later and continued language delays and disorders by preschool, with continued language difficulties that could persist into school age and beyond.

Risk Factors for the Development of Premature Infants

The research literature documents a number of variables that, alone or in combination, can put a premature infant further "at risk" for later developmental delays. One of these risks is very low birthweight (VLBW). In this study the link between decreased birthweights and increased risks was supported, as regression analyses revealed that lower birthweights were found to be a significant predictor of decreased PLS-4 (Zimmerman et al., 2002) scores at two years of age in this sample of African American premature infants. Lower birthweights have been found to put premature infants at additional risk for later developmental disabilities, and these risks increase as birthweight decreases (Koller et al, 1997). The results of the current study documented that later language, in particular, may be one domain of development specifically impacted by lower birthweights in African American premature infants.

Additionally, Neurobiological Risk Scores (NBRS) of the study participants at the time of discharge from the hospital were also found to be a significant predictor of later

PLS-4 (Zimmerman et al., 2002) scores. The nursery NBRS as recorded at the time of the infant's discharge from the NICU has been found to be a sensitive predictor of infant development in a number of studies. Brazy et al. (1991; 1993) documented correlations between the NBRS and developmental outcomes at 6, 15, and 24 months in premature infants born less than 1500 grams. In addition, Lefebvre et al (1998) documented significant relationships between NBRS scores and infant development, including a subscale of hearing and speech at 18 months of age. Thus, the findings of the current study mirror those of other studies, and indicate that NBRS scores used to document infant risk of developmental delays in premature infants at the time of hospital discharge can specifically predict later language difficulties in formerly premature infants at 2 years of age.

The current study results also support findings of longer periods of mechanical ventilation being related to poorer child developmental outcomes. Participants in this study who had longer total days of mechanical ventilation had statistically significant lower PLS-4 (Zimmerman et al., 2002) scores at 2 years of age. The requirement for mechanical ventilation and the number of days that the infant needs such assistance in the NICU have been documented in a number of studies as being risk factors for later premature infant developmental delays. Specifically, the literature reports that shorter durations of mechanical ventilation have been associated with greater developmental maturity in premature infants at 6 and 18 months of age (Vohr et al, 2003; Holditch-Davis et al, 2007). Current study results indicate that for those infants requiring longer days of mechanical ventilation, language scores at 2 years of age may be negatively impacted.

Finally, global levels of caregiver responsiveness in the current study during both nonfeeding and feeding footage were found to be predictive of later infant PLS-4 (Zimmerman et al., 2002) scores. The less responsive the caregiver was to the infant during all videotape footage for these African American premature infants at 6 months adjusted age, the lower the infants' PLS-4 scores were at 2 years of age. As stated earlier, the quality of the interactions between premature infants and their caregivers has been found to impact child development. Caregiver contingent responsiveness and the quality of infant caregiver interactions can affect developmental outcomes for premature infants. The current study results support the broader literature base with regard to the impact of the quality of caregiver and infant interactions and their relationships to later developmental outcomes (e.g. cognitive scores) in premature infants (Holditch-Davis et al, 2000). Specifically, these results indicate that more responsive mothers throughout all videotaped footage at 6 months had children who performed better on a standardized language assessment at 2 years of age, thus suggesting that reciprocity and responsiveness are important factors when considering early communicative interactions between premature African American infants and their caregivers and later infant communicative outcomes.

Mealtime Communication

In the current study, Mealtime Communication "Red Flags" Composite Scores at 6 months adjusted age were found to predict PLS-4 (Zimmerman et al, 2002) scores at 2 years of age. Specifically, children who had higher "red flags" composite scores (representing less communicative behaviors observed during feeding footage) at 6 months had significantly lower PLS-4 scores at 2 years. Mealtimes were observed to be a highly interactive time, with caregivers often engaging and responding to infant communicative bids, and infants in turn engaging in vocalizations and producing early gestures. Few research studies have documented communication specific to mealtimes, but the literature that is available supports the current study findings to some degree. For example, in a study of feeding and nonfeeding interactions of premature infants and their caregivers conducted by Holditch-Davis et al (2000), caregivers were found to interact with their premature infants 96% of the time during feeding, and 67% of the time during nonfeeding. Therefore, mealtime may be a particularly interactive and “rich” context in which to observe the communication between premature infants and their caregivers.

Given that there was a significant relationship between mealtime communication and later language scores in this group of premature infants, specific infant behaviors were analyzed and compared to other research findings on early communication. In particular, most of the gestures produced by the infants in this study occurred during the context of mealtimes. The gestures produced by the infants in this study were consistent with findings from previous studies with regard to the appearance of deictic gestures at approximately 7-9 months of age (Carpenter et al, 1998; Crais et al, 2004). Approximately 38% of the infants in this study were producing deitic gestures during mealtime that included turning the head and/or body away and pushing away or reaching for the bottle or spoon. Previous research has supported these findings, and documented that typically developing fullterm infants exhibit communicative behaviors such as reaching for the spoon when hungry at approximately 6 months of age (Carruth et al, 2002).

As stated earlier, the emergence of gestures is a hallmark of the emergence of intentionality in infancy (Crais et al, 2004); therefore, the current study findings suggest that feeding interactions may be a particularly salient context in which to observe and document early indicators of intentionality in premature infants. Bates (1976) defined intentional communication as the child's deliberate use of a specific signal to affect another person's behavior. Infants in the current study were expressing their intentions to their caregivers during mealtimes by indicating when they were hungry and when they wanted to stop bottle or spoon feeding through the use of clearly intentional communicative behavioral acts including gestures paired with vocalizations. The following sections will further discuss the communicative behaviors observed in this sample of African American premature infants and their interactions with their caregivers over the course of all nonfeeding footage.

Overall Early Communication

Overall Early Communication "Red Flags" Composite Scores at 6 months adjusted age were not found to be significant predictors of PLS-4 (Zimmerman et al., 2002) scores at 2 years of age. This finding leads the researcher to ask why communication specific to the period of mealtime was predictive of later language scores, but communication over all of the videotaped footage for each child was not? A number of reasons for this difference should be taken into consideration. Reasons for significant differences during mealtime versus nonsignificant findings for overall communication may have included less overall opportunities for infants to engage and respond to caregivers during nonfeeding footage. For example, mealtimes appeared to be a highly interactive context in which communication exchanges between infant and caregiver took place, most notably during spoon feeding. Mothers and infants alike were often witnessed to engage and respond to one another with vocalizations and gestures during mealtimes. In contrast during nonfeeding footage because of the nature of the home visits, mothers were often observed to be filling out questionnaires and infants who made communicative bids in these contexts were not always successful in engaging their caregivers. It should be noted that caregivers were told to “act as you normally would” while a stranger (e.g. research assistant) was videotaping the infant during the 45 minute home visit. Mothers may have felt more comfortable in knowing their “role” and what was expected of them during feeding than during other times when the videotape was rolling. Further, some mothers may not spend as much face to face time or in such close proximity to their children during other routine daily activities as they do during feeding interactions.

While the composite scores for overall communication were not predictive of PLS-4 (Zimmerman et al., 2002) scores in this study, there were some interesting findings with regard to the emergence of gestures in this group of African American premature infants. For example, a few of these 6 month old adjusted age infants were observed to have both deitic and representational gestures emerging. Some of the deictic gestures observed in this sample of infants included: turning the head and/or body away during mealtime to indicate “stop” or “all done”, reaching for the bottle, or pushing the spoon away, giving/showing toys, or reaching for toys/people. As stated earlier, the likely age ranges for observing the emergence of such gestures has been shown to be approximately 7-9 months (Crais, et al, 2004). The results of this study indicate that some of the infants at 6 months adjusted age in the current study sample were using age appropriate gestures for their chronological age.

Representational gestures, which usually appear later than deictic gestures, were also observed to be used by some of the current study participants. Some of the representational gestures observed included: "dancing", blowing a kiss, waving, shaking head "yes" and "no", playing "peekaboo", giving "high fives", and clapping hands during social interactions. Representational gestures such waving "bye-bye" were also observed. As stated earlier, the likely age ranges for observing the emergence of representational gestures has been shown to be approximately 9-10 months. The results of the current study indicate that some of the infants were beginning to emerge into representational gesture use, though it should be noted that a very small number of the study participants (7/42) made up those observed to produce the majority of the representational gestures listed above. It should also be noted that, for a small majority of the study participants, the emergence of gestures may have followed a developmental trajectory more closely related to their chronological age as opposed to their adjusted age of 6 months.

Additionally, vocalizations produced by the infants in this study were emerging into expected trajectories of vocal development as defined by Oller (2000). For example, Oller has stated that the onset of canonical babbling, which emerges between 4-11 months of age, is a significant milestone in the development of speech. Vocal development specifically in premature infants has been examined by Eilers et al (1993) and Oller et al (1994). These studies found that premature infants at a corrected age of approximately 6 months were emerging into the canonical babbling stage. It should be noted that while the above studies reported that prematurity and lower SES were not risk factors for later or delayed canonical babbling, the infants in these studies were “healthy” preterms of more than 1400 grams at birth and requiring only minimal care with no need for oxygen during hospitalization. In addition, these infants were from two parents families in which none of the caregivers had less than 12 years of formal education. The current study children were vocalizing at levels expected for typically developing infants their age; the current study documented that 100% of the 42 premature infants were observed to vocalize, 76% engaged in vocal play, 56% produced marginal babbling (e.g. CV syllables), and 40% engaged in canonical babbling (e.g. CVCV such as “mama”). As canonical babbling emerges in most infants by 10 months of age, the above statistics represent encouraging percentages of the study infants emerging into these speech skills at 6 months adjusted age. Additionally, research specific to the vocal development of VLBW premature infants has documented that while such infants were not canonically babbling at 8 months of age, all were producing speech sounds that were comparative to full term controls by 18 months of age (Rvachew et al, 2005). Such information suggests that the current study sample of African American premature infants appear at this time to be on a “typical” trajectory in the development of vocal behaviors. However, these infants were also at greater risk than infants observed in previous research, and it is unknown whether the 60% of current study participants who were not observed to engage in canonical babbling at 6 months adjusted age would have done so at other time points. Therefore, future research is still needed to document the continued vocal development of these most at risk premature infants over time.

Oral-Motor Feeding Difficulties

Oral-Motor Feeding Dysfunction "Red Flags" Composite Scores at 6 months adjusted age were not found to be significantly related to PLS-4 (Zimmerman et al., 2002) scores at 2 years in this sample of African American premature infants. A number of reasons may have accounted for this non-significant finding. The composites and a few specific items on them that were significant predictors of later PLS-4 scores will be discussed in the section to follow.

In both spoon and bottle fed infants there were items on the composites that were representative of feeding skills observed in 100% of the infants, thus raising the issue of ceiling effects. While these items did not impact composite scores, as only items that were indicative of "red flags" or difficulties were added to create the composite scores, these items still represented a proportion of items that may not have been sensitive to difficulties in this group at this age range, and thus could possibly be omitted in future versions of the scales. For example, in the spoon feeding group of infants, (n=21), 100% of the infants were observed to open their mouths in anticipation of the spoon, and to use lips to actively remove food from the spoon. In addition, 100% of all spoonfeeding infants had a smooth, rhythmic sequencing to removing food from the spoon and swallowing it, and none of these infants were witnessed to have mistimed swallowing events. In addition in the composite specific to bottlefeeding infants, two items were 100% correlated ("smooth, rhythmic sequence to sucking" and "sustained sucking") and were therefore collapsed into one item for the purposes of statistical analyses. Thus the Oral-Motor Feeding Dysfunction "Red Flags" instrument itself appears to have included items that were not sensitive to potential differences or difficulties in these premature infants.

It also is possible that the differences observed were a result of two groups of children in one sample who were truly different with regard to feeding dysfunction based on the mode of feeding observed at 6 months corrected age (bottle vs. spoon). Perhaps mothers of infants who were struggling with bottlefeeding had not yet attempted to make the transition to solid foods as they felt their infants had not yet mastered bottlefeeding and were not yet developmentally ready for solids. Thus even the fact that half the infants were not being spoon fed may have been a significant factor in the overall outcome. For example, in the current study infants who were bottlefed had almost three times the total number of instances of oral motor feeding dysfunction as compared to the spoon feeding infants (93 vs. 35 total instances, respectively). Indeed, Mathisen et al. (2000) reported that 80% of the premature infants in their study were struggling with both eating and drinking difficulties as well as inconsistent patterns of oral-motor development at 6 months corrected age. Therefore, the current study results confirm these findings, with some participants exhibiting some feeding skills that appeared to be developing typically, and others that appeared to be immature or dysfunctional oral-motor patterns. For example, only 57% of the bottle feeding infants (n=21) in the current study were observed to have a smooth, rhythmic sequence to sucking. Mathisen et al (2000) reported similar results, with 56% of their 20 extremely low birthweight (ELBW) premature infants observed to have a smooth, rhythmic sequence to sucking. These findings support the call for future research that Mathisen and others such as Burklow et al (2002) have requested in the literature, namely, that the mechanisms by which feeding problems develop in premature infants be examined in future research.

Finally, it should be noted and acknowledged that “feeding skills” involve so much more than “oral motor skills”. For example, respiration and the possible breathing difficulties that can impair feeding skills in premature infants are important factors to consider when examining feeding skills in this population. The current study acknowledged this important aspect of the feeding system with one item in the Oral Motor Feeding “Red Flags” Scales for both bottle and spoon feeding, by documenting whether the infants were observed to “work to breathe” during mealtimes. Future research examining the feeding and communication skills of premature infants should include greater details with regard to the respiratory aspects involved in feeding.

Dynamic Systems and Ecological Systems Models

The current study findings support the need for dynamic and ecological systems models in research that examine the feeding and communication development of premature infants. Current study findings suggest that environmental factors external to the infant such as levels of overall caregiver responsiveness may have contributed to infant developmental outcomes with regard to later language scores. In addition, there were a few infants who appeared to struggle during feeding at 6 months adjusted age with regard to oral-motor feeding skills and communication, yet their later language scores were well above the group mean. This information suggests resiliency within these particular infants with regard to overall development, as well as wide variations in patterns of individual differences (Koller et al., 1997) which have also been reported in the literature on premature infant development. Few studies of premature infants have been conducted from a systems perspective (Bhutta et al., 2002), yet available research has suggested that the quality of social environments impacts the development of VLBW premature infants (Holditch-Davis et al, 2000). Therefore, future research that views premature infant development within the frameworks of both transactional and dynamic systems models may allow for equal emphasis to be placed on both internal infant systems and external environmental systems that work both independently and in concert to contribute to developmental outcomes. The current study was a first attempt to examine and account for both infant and caregiver data that could have contributed to later language development in this group of African American premature infants.

Limitations of the Current Study

There are several limitations associated with this study that may affect the extent to which the results can be generalized to other individuals. First, a potentially limiting factor of the current study was the sample size. Based on a preliminary a priori power analysis conducted to determine the number of participants needed, if five variables were entered into a regression at one time a sample size of 50 subjects would have allowed for a minimum R squared of 23 percent or higher with a power of .80 at a significance level of .05 (Hair, Anderson, Tatham, Black, 1998). This would have been the highest number of variables entered into any one regression for the individual statistical analyses employed for this study. In addition, the original plan for this study proposed to examine the videotape footage of 50 infants with at least five minutes of spoon feeding footage. While the original MOMS study dataset included a total of 177 subjects, very few of these participants had footage available that met the requirements for the current study. Only 129 of the original infant participants had any videotape footage for the home visit at 6 months adjusted age. Of these, just 25 of the original subjects were spoon fed during the videotaped home visit at 6 months adjusted age. Therefore, 22 of these participants were used for the study (with three videos analyzed during piloting of the coding system), and another 22 participants were chosen at random from those with at least five minutes of available feeding footage including a bottle feeding. Unfortunately, the small sample size may not have allowed for enough power to document statistically significant results with regard to Overall Early Communication and Oral Motor Feeding Dysfunction “Red Flags” severity rating composite scores. Future studies of feeding and communication development in premature infants should ideally involve larger sample sizes.

However, it should be noted that this study was a first attempt to look at these issues and document descriptive information specific to this population, as there are very few studies thus far that have examined both feeding skills and early communication during feeding and nonfeeding interactions specifically in VLBW premature infants. In a related study, Massey (2005) documented preliminary support for the co-development of communication and feeding skills in her unpublished dissertation research study in which she followed 10 fullterm and 10 preterm infants over the course of one year. In terms of the current study, despite the sample size interesting findings were revealed with regard to the mealtime communicative behaviors of these African American premature infants and their caregivers. Specifically, the finding that mealtime communication was predictive of later language and cognitive scores in this group of infants warrants further study.

A second limitation of the current study was the presence of “outliers” or heavily influential participants who provided datapoints that also contributed to nonsignificant findings of specific composite items which were reversed when the data was considered without these participants in the model. The results of these three participants speak to the wide range of outcomes and the "resiliency" of some infants mentioned earlier, as well as the need for ecological models that examine all of the possible contributors to later infant developmental outcomes (e.g. environment, caregiver beliefs and attitudes, interactions with social partners). Therefore, the presence of these outliers is an interesting finding in that such data documents the wide variations in the development of these infants. These findings suggest that the resiliency of individual premature infants, as well as the multiple other factors/systems surrounding these infants that scaffold them and support their development, are important factors to consider in future research.

Finally, methodological issues with the study design may have contributed to limitations of the present study. The use of existing videotape footage that was originally recorded to code and document more generalized measures of infant caregiver interaction, and not specifically recorded to document feeding skills and/or behaviors, may be another limitation of the current study. Videotape footage was at times difficult to interpret due to lighting, camera movement, and distance of the camera from the infant. Also, video footage was from one point in time and may not have provided a complete picture as to infant feeding and communicative abilities and skills. In addition, caregivers may have acted differently in their interactions with their infants by communicating more or less than usual based on their comfort level with having a researcher and a video camera in their home. Feedings were also not presented in a standardized manner, and differences such as positioning (e.g. infant sitting in caregiver's lap versus in a highchair) may have impacted the information available to this study in documenting infant oral-motor feeding skills. However, this preliminary research methodology will lead to more refined coding and analyses of these behaviors and skills in future research, and future studies can address these limitations by controlling for feeding in a natural environment with a standardized presentation of liquids and solids, as in the Schedule for Oral Motor Assessment or SOMA (Reiley et al., 2000).

Despite the above methodological limitations, there were also methodological strengths to the current study. For example, all current study infants were fed in their home environment by their caregiver and with their familiar feeding utensils. Such naturalistic views of feeding may have allowed for the observation of communicative exchanges during mealtime that may not have been witnessed in an unfamiliar laboratory setting. In addition, much of the available literature on feeding skills development in infants has used interview methods for parent report of infant feeding skills rather than direct observations of infants and caregivers during feedings (Carruth et al., 2002). Other available research has been specific to mother infant interactions during feeding in a lab setting (Chatoor, Getson, Menvielle, O'Donnell, & Mrazek, 1997). Additionally, since all of the infants in the current study were from African American, rural families, cultural differences may have been lessened to the greatest extent possible while also providing the opportunity to document rich information with regard to descriptions of communication and oral-motor skills specific to a group of premature infants most “at risk” for developmental differences. The literature that is available with regard to typical feeding skills development is limited primarily to samples of white, higher SES families with two parents and increased caregiver education levels (e.g. Carruth, et al, 2002). Therefore, the use of existing home videotape footage of African American premature infants and their caregivers during both feeding and nonfeeding interactions provided ample opportunities to document infant communication in a number of social contexts.

A final limitation of the current study may have been the presence of differences between the bottle and spoon feeding participants. While the bottle feeding and spoon feeding participants were treated as one group for this study, the differences between these children were somewhat striking. Further exploration of the data also revealed that there was a significant difference between these groups of children with regard to the outcome variable, PLS-4 (Zimmerman et al., 2002) scores at 2 years. In addition, the bottle feeding children had a much larger number of overall instances of oral-motor dysfunction, with 93 instances as opposed to 35 for the spoon feeding children. It is interesting to note the unexpected results that were revealed in the differences between the bottle and spoon feeding subjects. While these differences may have been limitations of the current study, they also document the need for further research and comparisons between bottle and spoon feeding skills and later outcomes in premature infants. There have been suggestions in the literature that premature infants need to be followed closely from birth, given that medical and behavioral contributions to feeding problems can result in such difficulties appearing over time (Burklow et al., 2002). The current study was therefore successful in documenting the need for further investigations of the mechanisms by which feeding problems develop in premature infants. Further, the finding of significant differences in later language outcomes for premature infants fed by bottle or spoon at 6 months adjusted age argues for much more careful scrutiny of these children and their current and future skills.

Implications and Future Directions

The results of this investigation suggest several important directions for future research and outline some potentially beneficial areas of consideration for clinical practice. First, this study extends our current knowledge base with regard to the early communication skills of African American premature infants by considering the context of communicative interactions during mealtime as being shown to be a highly communicative time for infants and their caregivers. The current study identifies infant communication during mealtime in 6 month adjusted aged African American premature infants as a statistically significant predictor of later language and cognitive scores at 2 years of age.

Further, to this author's knowledge, the development of gestures in VLBW premature infants has not been specifically examined in the literature, nor has it been given the research attention that the development of vocalizations in this population has received. Due to the fact that the emergence of gestures provides a window through which to observe the development of communication skills (Crais, et al., 2004), paired with research findings that suggest significant later language delays in VLBW premature infants, the current study findings warrant further research to document the developmental trajectory of gesture development in VLBW premature infants. These results could provide an intervention context for providers of early supports and services, with opportunities to scaffold and support communication within the dyad specifically during mealtime interactions.

There are remarkably few studies of feeding problems in premature infants from which to glean information as to how best to examine, observe, and document feeding skills in this population (Schadler, Suss-Burghart, Toschke, von Voss, & von Kries, 2007). Future research should aim to expand the methodology and findings of this study to include larger sample sizes and infants observed during mealtime. In addition, future studies would ideally observe the same infants over multiple visits consuming liquids and solids in multiple modes (e.g. both bottle and spoon feeding), while also interviewing caregivers about their beliefs and observations of their infants feeding skills. Future research could further examine communicative interactions of premature infants and their caregivers during feeding and nonfeeding contexts, and could serve to influence early screening, identification, and interventions for at risk infants and young children and their families.

Finally, the research finding that mealtime communication at 6 months adjusted age was predictive of language scores at 2 years in this group of premature infants suggests that mealtimes may provide a rich context in which to observe communication skills in other populations of “at risk” infants. For example, adaptations of the current study coding system could be used in future research to examine the mealtime communication of children who are also at risk of other developmental delays. Children with Autism Spectrum Disorders, in particular, could possibly be identified as having “red flags” of communication difficulties during mealtimes that may predict later language. Such future research could include retrospective video analyses of children already diagnosed with ASD to examine earlier mealtime interactions specifically. Another possibility for future research with this population would be to examine the mealtime communication of infant siblings of children diagnosed with ASD to determine whether predictive relationships exist between early mealtime communication and later language scores. Replications of the current study findings would be an important first step in determining the saliency of predicting later language scores from mealtime communication in infancy.

Final Conclusions

It is commonly accepted that communication begins well before the onset of speech, and it is currently suggested both clinically and theoretically that feeding and speech development are related, at least in the first year of life (Morris & Klein, 2000). Despite these suggestions, there is paucity of research specific to the relationship, if any, between feeding skills and speech and language development. The current study has provided some support for the projected hypotheses and rejected others. The study provided preliminary support for the hypothesis of a relationship between mealtime communication at 6 months adjusted age in African American premature infants and later language scores. The findings from the current study contribute to our knowledge of the emergence of intentionality and communicative behavioral acts during mealtime in a group of African American premature infants. This study also provides preliminary evidence to support future research in these areas, as well as the possible future creation of early screening and identification tools and early interventions embedded within the context of mealtime interactions. The current study can be embedded within the larger framework of efforts analyzing the factors that contribute to successful communication, and identifying those that have the largest effect on later child language. Of particular interest is the finding that mealtime communication at 6 months adjusted age is predictive of later language and cognitive scores at 2 years of age in this group of African American premature infants. This finding identifies an important rationale for future research in this area, and future studies are needed to further examine the relationship between communication observed during mealtimes and later speech and language skills.

While the hypothesis that oral-motor feeding dysfunction in premature infants at 6 months adjusted age would be related to later language scores was not met, the fact that approximately half of the infants in this study were still struggling with basic oral-motor skills during bottle feeding at 6 months adjusted age is striking, and confirms the need for further research with regard to the ongoing feeding difficulties experienced by some premature infants. The results of the current study were similar to those of Mathesien et al (2000), who reported that 80% of the premature infants in their study had ongoing feeding difficulties. Unfortunately, there are very few studies of feeding problems in formerly premature infants (Schadler et al., 2007), and no studies of feeding problems with regard to their long-term implications. The lack of research in these areas indicates the need for future research that further describes the feeding skills development of premature infants, and the difficulties that emerge at various time points and feeding transitions during the first year of life in this population.

What is needed in the clinical realm is a practical instrument that codes mother and infant interactions and infant communicative behaviors and oral motor feeding skills during mealtimes in the first year of life. Further research could assist in the creation of such an instrument, which could theoretically examine both oral motor feeding skills and areas of difficulties as well as communication development within the context of mealtime interactions. Future research should aim to control for the limitations of this current study by increasing sample size, improving on current study methodology, and examining feeding and communication development in premature infants through the use of transactional models and dynamic systems frameworks.

APPENDIX:

Coding Manual

There are a total of **3 coding sheets** that you will fill out for each video that you watch:

1. *Overall Early Communication "Red Flags" Severity Rating Scale*: to be completed for each child while watching the entire videotape (+/- 45 minutes). This coding sheet will be used to document child vocalizations and any gestures or body language used by the child during the entire videotape footage. You will note a "Yes" or "No" for whether or not you observe the listed communicative behavioral acts. You will also describe/list different types of communicative acts. Then you will document if you see a particular type of act (e.g. use of a gesture) more than once during the footage.
2. *Mealtime Communication "Red Flags" Severity Rating Scale*: to be completed for each child while watching feeding footage. Once you see the first instance of "bottle in" or "spoon in", rewind the tape back two minutes (or to the beginning if less than two minutes) and have this scale in front of you. You will document similar communicative acts as you have been noting on the *Early Communication Scale*, but the ones noted on this scale will be the communicative acts that happen immediately (up to two minutes) before, during, and two minutes after any feeding activities. Some may be used on both sheets.

3A. *Oral-Motor Feeding Dysfunction Severity Rating Scale- Bottle Feeding:* to be completed while watching the feeding footage, which again is considered the two minutes prior to the first "bottle in" until two minutes after the end of any bottle feeding opportunities. On this scale you will document a “Yes” or “No” on various oral motor and feeding skills (e.g. whether or not the infant is observed to cough or choke while taking the bottle). You will also describe the infant’s body position and support (see definitions found further in this coding manual).

OR 3B. *Oral-Motor Feeding Dysfunction Severity Rating Scale- Spoon Feeding:* to be completed while watching the feeding footage of spoon feeding infants during the two minutes prior to the first “spoon in” to two minutes after the mealtime ends. Again, you will document a “Yes” or “No” as to whether you observe listed oral-motor feeding skills.

The following sections will lay out, in detail, each coding sheet, and will define each item numbered on the scales to provide examples of what “are” or “are not” considered examples of each of the skills or behaviors to be documented. For each scale described, it may be helpful to have the sheet in front of you while you read over this manual, so that you can look at each item and follow along with the details of how to code each specific item on the scale (see sheets at end of codebook).

Early Communication “Red Flags” Severity Rating Scale

NOTE: For all communicative acts coded on this sheet, please attempt to describe or list what you heard or saw that qualified as the communicative act; ALSO, **please write the time** on the video timing tracker where the event occurred on the scale so that we may fast forward and watch the tape again should we need to reach consensus on an item. For example, if you saw a gesture occur 5 minutes and 15 seconds into the video, write down what the gesture was (e.g. infant persistently pushed caregiver hand away during feeding) and at what time it took place. If one of us saw a gesture and the other did not, this will enable us to find the instance on the videotape and watch it together to reach agreement.

Also, keep in mind that the average adult attention span is 20 minutes. These videotapes are about 45 minutes each; give yourself a short break (get up and move around) every 20 minutes or half way through each tape that you are watching.

When you are ready to begin coding, please refer to the following directions for each of the items on this scale.

1. Infant **looks** at caregiver's face at least once during footage: document as "Yes" if you see the infant do the following:
    a) focus eyes/attention on the caregiver's head or face for at least two continuous seconds.
    b) Check +1 if you see this occur more than once during the video.
    c) If the child never looks at the caregiver's face during the video, or the look is fleeting, (e.g. looks and immediately looks away), record as "No" for this item.
2. Infant **engages** the caregiver and initiates communication. Document as "Yes" if you see the infant
    a) **smile** at caregiver to get the attention of or attract the caregiver, and is successful in getting the caregiver's attention. Uses the smile to initiate reciprocal communication (such as caregiver smiles back or talks).
    b) **vocalize** to get the attention of the caregiver. You may note that the child successfully engages the caregiver when the caregiver responds to infant vocalization. For example, infant may vocalize in protest, and caregiver responds.

c) Please check off or write on the coding sheet how the infant engaged or got the attention of caregiver.

d) Check +1 if you see any of these behaviors occur more than once during the video.

e) If the child never engages the caregiver during the video, record as “No” for this item.

3. Infant **responds** to caregiver. Document as “Yes” if you see the infant do the following

a) **smile** at caregiver in response to caregiver talk, smile, or gesture;

b) **vocalize** when first talked to by the caregiver. For example, the caregiver may build on what the child said, e.g. caregiver says “do you want the balloon?” infant responds with “a-ba”, and caregiver says, “yes, balloon”.

c) **Gesture** or infant imitation of a caregiver action, e.g. caregiver says “Say no, shake your head no”, and the infant responds by imitating the gesture of shaking head.

d) **Turn** to look at caregiver in response to caregiver saying infant’s name.

e) Please check off or write on the coding sheet how the infant responded to caregiver.

f) Check +1 if you see any of these behaviors occur more than once during the video.

g) If the child never responds to the caregiver during the video, record as “No” for this item.

4. **Infant Vocalizes** during observed footage/observational period:

    a) document as “Yes” if you hear the infant make **any non-crying** soft, throaty, gurgling sounds; grunts, vowels, squeals or consonant sounds; raspberries are other examples that would count as a vocalization.

    b) do NOT include “vegetative sounds” such as coughs, sneezes, hiccups, or burps as vocalizations.

    c) If you can, write on the coding sheet what you heard and are documenting as a vocalization, (e.g. infant makes a raspberry sound, infant says “maa” which would count both here as a vocalization and again as item 6 further down the coding sheet- put in both places).

    d) Check +1 if you hear more than one vocalization during the video footage.

    e) Please make sure you are not recording background noises (e.g. television, other environmental sounds). Ideally you will see the infant’s face and mouth movement during the vocalization coded.

    f) If the child never vocalizes during the observed footage, check “No” and skip down to item numbers 7 and 8 on the coding sheet to document any gestures or non-verbal acts.

5. **Infant engages in vocal play or marginal babbling:**

    a) document “Yes” if you hear the infant produce consonant or vowel sounds that sound as if the infant is playing with his or her voice or full vowel-like sounds with contrasts among the vowels

b) Examples include long vowel sounds with changes in pitch, intonation, loudness; strings of vowels together; strings of squealing sounds

c) Examples above should sound like infant is “playing” with his or her voice

d) Check +1 if you hear more than one instance of vocal play during the video.

e) “No” if you never hear the infant engage in vocal play.

6. **Infant produces CV or VCV canonical syllables (e.g. ma, ba, aba):**

a) document “Yes” if you hear the infant produce a a clear consonant sound (C) in combination with a vowel sound (CV). Adult like, rapid timing should be clearly heard between the C and V, resulting in a clear CV or VCV syllable.

b) Examples include: ma, aba, ba. If you can, write on the coding sheet what you heard and are counting as CV sound or VCV canonical syllables.

c) Check +1 if you hear more than canonical syllable during the video.

d) Check “No” if you never hear any canonical syllables.

7. Infant produces reduplicated or **canonical babbling CVCV sounds:**

a) document “Yes” if you hear the infant produce a combination of CVCV sounds.

b) Examples include: mama, baba, dada. NOTE: to be considered reduplicated canonical babbling, the infant must produce a well-formed CV sound **immediately** following a CV sound, with adult-like rapid timing. *Reduplicated* CVCV babbles include strings of identical CV syllables; you are less likely to hear at this age *variegated* CV babbles, which include syllable strings that vary in the C, the V, or both (e.g. maba or gaba). If you can, write on the coding sheet what you heard and are counting as a CVCV sound.

c) Check +1 if you hear more than one CVCV sound during the video.

d) Check "No" if you never hear any CVCV sounds.

8. Infant attempts to **imitate** a sound, word, or gesture:

a) document "Yes" if you hear or see the infant attempt to imitate a sound, word, or gesture made by the caregiver.

b) Examples would include: caregiver shaking head "no", and infant imitates head shaking; caregiver says "look, a balloon", infant says "a-ba" and caregiver responds, "yes, balloon".

c) Do NOT document as "imitation" if the infant produces the sound, word, or gesture more than one full minute after an adult model. Please write on the coding sheet what you saw or heard as imitation occurring by the infant.

d) Check +1 if you see the infant imitate more than once.

e) Check "No" if you never see the infant attempt to imitate.

f) NOTE: You would NOT code as imitation if the caregiver told the infant to do something, but did not demonstrate it, and the infant followed the verbal direction. For example, a caregiver may say "kiss the baby", giving the infant a doll, but the caregiver does not demonstrate the gesture of kissing the baby. If the infant then kisses the baby doll in response, this would not count as the infant imitating a word or gesture.

9. **Infant Gestures (non-verbal act)** during observed footage: A "gesture" or non-verbal communicative act in this definition could involve the hand and arm movements (e.g., insistently batting away a bottle or caregiver hand), or body wide movements (e.g., arching or turning away from caregiver while being fed) *in response to or to engage the caregiver during a clear interaction.*

   a) document "Yes" if you see the infant reaching, showing or giving an object, clapping, pulling, pushing, shaking head, or turning/arching the body away. These acts could include requesting or protesting body movements or behaviors. Please write on the scale what you saw as a gesture.

   b) It must also be very clear that the infant is being clearly intentional in his or her behavior- this means that in addition to the actual body movement or gesture, the infant must convey that he or she is *directing this behavior towards another person for the purpose of communicating something.* Therefore, in addition to the gesture behavior, the infant must ALSO be looking at, vocalizing to, or otherwise be attempting to get the attention of another person for the behavior to be considered a gesture.

   c) Examples could include: fussing and looking at Mom while reaching for food, vocalizing and reaching for the bottle.

d) Facial expressions (such as smiling) DO NOT count as non-verbal communicative acts for the purposes of this study, as they could be reflexive at this age and not necessarily conveying communicative meaning.

e) Check +1 if you see the infant gesture more than once.

f) Check "No" if you never see the infant gesture or use body language to communicate his or her wants, needs, or pleasure.

Total= One point for every shaded/no answer. Low scores indicate less risk, whereas higher scores may possibly be more indicative of early "red flags" of later communication delays or disorders.

Qualitative Caregiver Ratings-

The Qualitative Caregiver Ratings listed below are provided to give a gross (overall) picture of what the caregiver is doing to engage the infant in communication or to respond to the infant during the observed videotape footage. These ratings are to provide a general "bigger picture" of communication between infant and caregiver; for example, if the caregiver is not talking to the infant or demonstrating any contingent responsiveness to infant cues or communicative bids, this information may help to explain why this particular infant is more quiet or less communicative themselves.

NOTE: If multiple people can be seen on the video, always code the parent/primary caregiver who can be seen on the video for the majority of the time.

1. **Caregiver** talks to and/or gestures to the infant: Does the caregiver ever talk to and/or gesture to the infant during the videotape footage? Document as Y or N for Yes or No.

2. **Caregiver** is verbally responsive to infant communicative bids: does the caregiver ever respond to the infant when he or she fusses, cries, or gestures? Document as Y or N

3. **Caregiver** reciprocates/responds to **social** bids by the infant: does the caregiver ever show any emotion/affect or smile in response to the infant's attempts (e.g. if infant smiles at caregiver, does caregiver smile back in response?) Document as Y or N

4. **Caregiver** gross/global level of verbal or social responsiveness or reciprocation:

High- caregiver frequently responds to the infant throughout the videotape footage

Occasional- caregiver does not always respond to infant bids (e.g. distracted attention)

Never- caregiver never responds to any of the infant's bids (e.g. never smiles in response)

<u>Mealtime Communication "Red Flags" Severity Rating Scale</u> (see coding sheet)

Note: This scale is only completed during the feeding interaction on the videotape, which begins TWO minutes before the first instance of either the spoon or the bottle being presented to the infant. This scale is used in conjunction with one of the "Oral-Motor Feeding Red Flags Severity Scale" coding sheets; this sheet will be used to document communicative acts during the mealtime.

1. Infant **looks** at caregiver's face at least once during feeding:

a) Document as "Yes" if you see the infant's attention focus on the caregiver's head or face for at least two continuous seconds during the feeding.

b) If the child never looks at the caregiver's face during the feeding, or the look is fleeting, (looks and immediately looks away), record as "No" for this item.

2. Infant **engages** caregiver **during feeding:** document as "Yes" if you see the infant do the following-

a) **smile** at caregiver to get or attract the attention of caregiver during feeding;

b) **gesture or vocalize** to get the attention of the caregiver during feeding.

c) Please check off or write on the coding sheet how the infant engaged caregiver.

d) If the child never engages the caregiver during the feeding, record as "No" for this item.

3. Infant **responds** to caregiver during feeding: document as "Yes" if you see the infant do the following-

a) **smile** at caregiver in response to caregiver talk, smile, or gesture;

b) **vocalize** when first talked to by the caregiver during feeding. For example, the caregiver may build on what the child said, e.g. caregiver says "time to eat, mmm mmm" infant responds with "mmm", and caregiver says, "yes, yum".

c) **Gesture** or infant imitation of a caregiver action during mealtime, e.g. caregiver says "bang bang bang" and bangs the spoon on the tray, and then gives the infant the spoon; the infant responds by imitating the gesture of banging the spoon on the tray.

d) **Turn** to look at caregiver in response to caregiver saying infant's name.

e) Please check off or write on the coding sheet how the infant responded to caregiver during feeding.

f) Check +1 if you see any of these behaviors occur more than once during the video.

g) If the child never responds to the caregiver during mealtime, record as “No” for this item.

4. **Vocalizes** at all during observed **feeding footage:** Score as a Yes if you hear-

a) **non-crying** soft, throaty, gurgling sounds, vowels, consonants, CV syllables, or CVCV babbling during the mealtime. Please describe by writing down what the vocalizations were that you heard during the mealtime.

b) Score as a No if you didn’t hear the infant vocalize at all during the two minutes prior, during the mealtime, or two minutes after the feeding ends.

5. Infant attempts to **imitate** a sound, word, or gesture **while feeding**:

a) Score as Yes and describe or list on the coding sheet how/what the infant imitated during the feeding footage.

b) Score as a No if the infant does not imitate anything during the feeding.

6. **Infant Gestures** (non-verbal act) during observed **feeding footage:**

a) Score as a yes if you notice the infant request or protest during the meal by reaching, pulling, pushing away, shaking head, turning the face and/or body away or other non-verbal communicative acts.

b) *It should be clear that the infant is not just doing rhythmic body movements (e.g. hand flapping), but is trying to communicate by also pairing the gesture with looking at the caregiver and/or vocalizing.* Describe and list what you see and are documenting as an infant gesture during the mealtime footage.

c) Score as a No if you do not see any infant gestures or body language being used during the mealtime footage.

Total= One point for every shaded/no answer. Higher scores may possibly be more indicative of early "red flags" of later communication problems.

Qualitative Caregiver Ratings-

1. **Caregiver** talks to and/or gestures to the infant **during feeding**?

Document as Y or N for Yes or No.

2. **Caregiver** is responsive to infant feeding cues or signals during mealtime (e.g. senses infant distress or discomfort and is able to stop/start/change position of the infant for optimal infant comfort and stability during feeding).

Document as Y or N

3. **Caregiver** reciprocates/responds to **social** bids by the infant or makes social bids during mealtime: does the caregiver show emotion, affect, or smile at the infant in response to infant emotions or attempts at social interactions during feeding?

   Document as Y or N

4. **Caregiver** gross/global level of verbal or social responsiveness or reciprocation during feeding footage:

High- caregiver frequently responds to the infant throughout the feeding footage

Occasional- caregiver does not always respond to infant bids (e.g. distracted attention)

Never- caregiver never responds to any of the infant's bids during mealtime

Oral-Motor Feeding Skills: Bottle Feeding (see scale at end of coding manual)

NOTE: For all oral-motor feeding skills coded on this scale, **please write on the scale the time** on the video timing tracker where the event occurred so that we may fast forward and watch the tape again should we need to reach consensus on an item. For example, if you saw a cough, gag, or choke occur 5 minutes and 15 seconds into the video, write down what you saw and at what time it took place. If one of us saw a dysfunctional oral-motor feeding pattern and the other did not, this will enable us to find the instance on the videotape and watch it together to reach agreement.

1. **Anticipatory mouth opening** most of the time: score as Yes if the infant opens his or her mouth to accept the nipple of the bottle in response to the bottle approaching. Score as a "No" if infant rarely opens mouth for bottle.
2. **Panic reactions** score as a Yes if you observe the following during presentation of the bottle or at any stage of the swallow:
    a) eyes widening, increase of tension, or gag
    b) infant appearing distressed on presentation of the bottle,
    c) possibly swatting the spoon away while crying, or pushing Mom's hand away with the spoon in it while also crying and fussing.
    d) Infant may look as if they are saying "stop" by putting out his or her hand, while also acting uncomfortable or upset.
    e) Infant may arch and push away
    f) You may or may not hear crying or view a panic reaction immediately before or after an audible swallow or cough/choke.
3. **Able to settle onto nipple and/or initiate sucking once in mouth:** score as a Yes if you observe:
    a) That the infant is able to settle in and begin sucking without any delay in the sucking process once the bottle is introduced and the nipple is in the mouth. If there are multiple onsets, the infant is able to do this

most of the time at the onset of the presentation (for more than half of the onsets).

b) NOTE: If the infant is distracted by others in the room (e.g. loud cousin playing on the floor with toys) and stops sucking the bottle frequently to turn and look at what is going on, this would not be the same as the infant not being able to settle onto the nipple due to oral motor feeding struggles

c) Score as a No if the infant is not able to settle onto the nipple

d) Or if the infant accepts the nipple into the mouth but does not actively suck

e) If the infant is not able to settle onto the nipple you may see him or her quickly stop sucking, arch back or turn away, or push the bottle away with his or her hand.

f) Caregiver may have to start and stop repeatedly if the infant seems unable to settle onto the nipple and/or initate sucking once it is in the mouth.

4. **Seal Observed**: score as a Yes if you observe

a) no liquid loss- no “drooling” of liquid down chin or sides of mouth

b) **and/or** the nipple of the bottle is not easily pulled out of the mouth by the caregiver.

c) You may be able to see the upper and/or lower lip seal firmly around the nipple to extract liquid as part of the sucking action.

d) Score No if you see loss of fluid (poor lip seal) at any point during the bottle feeding.

e) However, if you ONLY see fluid loss at the very end of the feeding (for example, infant is falling asleep at the end of the bottle feeding and is losing the lip seal as he or she falls asleep), give the infant credit and score this instance as a YES for observing a seal, as he or she did have a seal for the majority of the awake and active part of the bottle feeding.

5. **More than intermittent liquid loss throughout feeding** (>50% time): score as a Yes if you observe

a) The infant losing liquid (e.g. you can see it flowing out of the mouth or leaking out the sides of the mouth during the majority of the feeding).

b) At the end of the feeding if the infant is falling asleep and loses some liquid, this would be a No.

6. Continuous or repeated **Audible suck/click/swallows:** score as a Yes if you

a) hear clicking, sucking, or swallowing sounds

b) such sounds are heard off and on or throughout the bottle feeding.

c) Smacking sounds that are noticeable off and on throughout the feeding would count as continuous or repeated sounds, so score as a Yes in this example.

d) Score as No if you only hear this once, or at the beginning of the feeding as the infant is latching onto the nipple.

7. **Smooth, rhythmic sequence to sucking:** score as a Yes if you observe

a) A smooth sequence of at least three or more suck swallows.

b) A rhythmic suck is one in which no coordination difficulties with integrating the suck/swallow/breathe are noticed, and the rhythm of the sucking bursts are consistently smooth.

c) Score as a No if you observe coordination problems- the infant never seems to get into a “rhythm” with sucking, starts and stops frequently, or needs to pause often and may only take one or two sucks before taking a break. However, you may see an infant who “starts and stops” sucking frequently because he or she is distracted (for example, by a sibling playing nearby with a noisy toy); this would not be the same as an infant who seems unable to develop a rhythmic pattern to sucking because he or she is struggling with the feeding itself in terms of latching onto the nipple and sucking effectively and efficiently in a smooth pattern.

8. **Sustained sucking:** score as a Yes if you observe:

a) The infant completing long sucking bursts (four or more sucks in a row) without frequent sucking pauses or breaks.

b) If the infant has to pause frequently, or is unable to take more than one or two sucks without stopping, score as a No.

9. **Infant observed to be working hard to breathe:** score this item as a Yes if you observe:

a) Infant’s nostrils flaring, chest movements, or rib cage expanding (e.g. use of accessory muscles observable such as obvious chest expansion and retraction),

b) And/or infant frequently pausing and/or gasping for breath during the feeding.

c) And/or infant’s head looks like it is bobbing up and down, which can be seen if the infant is using the neck accessory muscles to work to breathe while eating

d) Score as No if you see effortless breathing during feeding and do not notice any obvious problems with trying to breathe (as described above) while taking the bottle. Note: you may see an infant on supplemental oxygen, however, you may or may not witness him or her struggling to breathe during the bottle feeding; being on oxygen alone does not justify a “YES” score on this item of observing the infant working hard to breathe.

10. **Cough, choke, or gag:** score as Yes if you observe:

a) Infant cough, choke, or gag during observation period (during or right after the meal).

b) Score as a No if there were no behavioral indicators of a mistimed swallowing event during the feeding.

11. **Multiple cough, choke, or gag:** score as Yes if during the observational period you see the child cough, choke or gag more than once.

12. **Munch or chew of nipple:** score as a Yes if you observe:

a) The infant munching or chewing on the nipple at the start or middle of feeding (at any time other than at the end of the feeding)

b) Do not score as a Yes if you see the infant munch or chew the nipple at the very end of the feeding, as this may indicate he or she is finished and is no longer interested in eating.

c) Score as a No if you do not see the infant munch or chew on the nipple, or if you are unsure or cannot tell if the infant was munching or chewing the nipple during the feeding.

Total= one point for every shaded item circled; total number of dysfunctional (shaded) skills noted.

NOTE: For all feeding footage, note the following on the "Oral-Motor Feeding Dysfunction Severity Rating Scale" bottle or spoon feeding coding scales:

Body Position: How was the infant positioned during the feeding? Note whether he or she was positioned on his or her back (supine), side lying, semi-sitting with support of an adult, chair, or cushions, sitting upright with trunk support e.g. in a highchair.

Support: Note type of support provided (e.g. sitting in a highchair, sitting on caregiver lap) and any head support. NOTE: The infant may be offered support that is inadequate/not enough for him or her, if you observe this to be the case please describe.

Food: If you can see or the caregiver talks about the food, note what the child is being fed (e.g. jar baby food, mashed bananas on a tray or plate).

Tools: Note any tools the caregiver uses to feed the infant (e.g. bottle, spoon, cup).

<u>Oral-Motor Feeding Skills: Spoon Feeding</u> (see coding scale at end of coding manual)

NOTE: For all oral-motor feeding skills coded on this scale, **please write on the scale the time** on the video timing tracker where the event occurred so that we may fast forward and watch the tape again should we need to reach consensus on an item. For example, if you saw a cough, gag, or choke occur 5 minutes and 15 seconds into the video, write down what you saw and at what time it took place. If one of us saw a dysfunctional oral-motor feeding pattern and the other never did, this will enable us to find the instance on the videotape and watch it together to reach agreement.

1. **Anticipatory mouth opening** most of the time: score as Yes if you observe:
   - **a)** The infant opens his or her mouth to accept the spoon or food in response to the food approaching during most of the presentations of the spoon (more than half the time).
   - **b)** Score as a No if the infant turns away, shakes head no, or otherwise indicates that he or she does not want the food or the spoon on most presentations.
2. **Panic reactions** score as a Yes if you observe:
   - a) eyes widening,
   - b) increase of tension, and/or infant appearing distressed on presentation of the spoon, possibly swatting the spoon away while crying, or pushing Mom’s hand away with the spoon in it while also crying and fussing. You may or may not hear crying or view a panic reaction immediately before or after an audible swallow or cough/choke Infant may look as if they are saying “stop” by putting out his or her hand,

while also acting uncomfortable or upset. Infant may also arch and push away

c) and/or gag during presentation of the spoon

d) and/or at any stage of the swallow.

e) Panic reactions might be seen at any point during the feeding interaction

f) Score as a No if you do not observe any panic reactions during the feeding

3. **Lips are active: closure of upper and/or lower lips on spoon**: score as a Yes if you observe:

   a) Infant's lips are actively moving (for example, upper lip moves forward and downward, and postures on the spoon as it enters the mouth; lower lip also begins to turn inward as the spoon is removed).

   b) You may be able to see the upper and/or lower lip seal firmly around the spoon to clean the spoon of food or remove food from the spoon.

   c) Score as a No if you note that the lips are passive and not moving to approximate the spoon. You may notice that if the lips are not moving to actively clear food from the spoon, the caregiver may frequently scrape the spoon up to remove the food from the spoon and into the infants mouth

4. **More than intermittent food loss throughout feeding** (>50% time): Score as a Yes if you observe:

a) The infant losing food (e.g. you can see it coming out of the mouth or leaking out the sides of the mouth during the feeding).

b) You may notice the infant losing most of the food out of the mouth from the very beginning of the feeding or after a few spoonfuls have been presented.

c) At the end of the feeding if the infant is falling asleep and loses some food, this would be a No.

d) Score as a No if you see no food falling out of the mouth during the feeding, or only a couple of instances during the entire feeding.

5. Continuous or repeated **Audible suck/click/swallows:** score as a Yes if you hear:

a) clicking, sucking, or swallowing sounds off and on

b) or throughout the feeding.

c) Smacking sounds that are noticeable off and on throughout the feeding would count as continuous or repeated sounds, so score as a Yes in this example.

d) Score as No if you only hear these sounds only once, or not at all.

6. **Smooth, rhythmic sequence of at least 3 or more suck swallows, munching actions or chewing actions are seen:** score as a Yes if you observe:

a) A smooth sequence of at least three or more suck swallows, munches, or chewing actions.

b) There should be no coordination difficulties with integrating the chew/munch swallow.

c) Score as a No if you see the infant struggle with coordinating chewing and swallowing, or if these actions appear difficult, strained, or exaggerated.

7. **Infant observed to be working hard to breathe:** score this item as a Yes if you observe:

    a) Infant's nostrils flaring, chest movements, or rib cage expanding (e.g. use of accessory muscles observable such as obvious chest expansion and retraction),

    b) And/or infant frequently pausing and/or gasping for breath during the feeding.

    c) And/or infant's head looks like it is bobbing up and down, which can be seen if the infant is using the neck accessory muscles to work to breathe while eating

    d) Score as No if you see effortless breathing during feeding and do not notice any obvious problems with trying to breathe (as described above) while spoon feeding. Note: you may see an infant on supplemental oxygen, however, you may or may not witness him or her struggling to breathe during the bottle feeding; being on oxygen alone does not justify a "YES" score on this item of observing the infant working hard to breathe.

8. **Cough, choke, or gag:** Score as Yes if you observe:

a) a cough, a choke, or gag during observation period (right before, during, or right after the meal).

b) Gagging may occur at the sight of the food or the spoon, when food enters the mouth, or when food is moved back on the tongue in preparation for swallowing.

c) Score as a No if there were no behavioral indicators of a mistimed swallowing event during the feeding.

d) NOTE: In some cases, the infant may be given a liquid to drink in between spoonfuls of food. If an infant was doing well with the spoon feeding, but then coughs and chokes after a cup of water is presented, this would not count towards a cough, choke, or gag on the food. For example, an infant may be spoon fed and doing well, and then mother offers a cup of water. Infant coughs and chokes on the water, followed by a cough or choke after the next spoonful of food. This would NOT be counted as a cough or choke, as the infant may have had residual thin liquid (water) in the airway and still been coughing as a result of that, and not on the spooned food.

9. **Multiple cough, choke, or gag:** score as Yes if during the observational period you see the child cough, choke or gag more than once.

10. Consistent/considerable **protrusion of tongue** (>50% of time): score as a Yes if you observe:

a) The infant's tongue is often visible and coming out of the mouth during most of the feeding.

b) Score as a No if you see only occasional or minimal protrusion of the tongue, e.g. the tongue protrudes occasionally when swallows occur or to clean the lips, but does not interfere with the range of tongue movements or ability to manage the food.

11. **Suckle or sucking pattern instead of munch pattern or rotary movement observed in chewing:** Score as a Yes if you observe:

a) a "suckle pattern" in the infants consumption of spoon fed foods. A "suckle pattern" consists of extension-retraction of the tongue (you can see the tongue moving in and out of the mouth), with opening and closing of the jaw in a rhythmical action and loose approximation of the lips- the lips do not assist in food removal. A "sucking pattern" would consist of raising and lowering of the tongue body with smaller jaw movements and tighter lips. A munching pattern would look like repetitive jaw movements in which the tongue and jaw begin to work independently of one another.

b) You should begin to notice the upper lip moving downward and forward to assist in food removal from the spoon. Chewing and/or munching involve this separation of movements, with the tongue flattening and spreading as the jaw moves up and down.

c) Score as a No if the infant is observed to use a munch pattern, (jaw moves up and down with limited movement) OR if a rotary chew pattern of jaw movement is observed.

Overall Early Communication "Red Flags" Severity Rating Scale

		Yes	+1	No
1	Infant **looks** at caregiver's face at least once during footage:	y		n
2	Infant **engages** caregiver: **smiles** at caregiver, gains attention_____ **vocalizes** for attention______ Other:	y		n
3	Infant **responds** to caregiver: Smiles back___ vocalizes in response____ turns in response to name____ Other:	y		n
4	**Infant Vocalizes** during observed footage/observational period (**non-crying** soft, throaty, gurgling sounds, quasivowels, raspberries) Describe:	y		n
5	**Infant engages in vocal play** changing pitch and/or inflection Describe/list:	y		n
6	Infant produces **CV or VCV canonical syllables** (e.g. ma, ba, aba) Describe/list:	y		n
7	Infant produces reduplicated or **canonical babbling CVCV sounds** (e.g.mama, dada, nana) Describe/list:	y		n
8	Infant attempts **to imitate** a sound, word, or gesture Describe/list:	y		n
9	**Infant Gestures** (non-verbal act) during observed footage e.g. request or protest by: reaches___ pulls___ pushes away___ shakes head____ turns/arches away___ Other describe/list:	y		n
	Total (one point for every shaded/no answer)			

Caregiver talks to and/or gestures to the infant? **Y N**
Caregiver is responsive to infant communicative bids (to fuss/cry/gestures?) **Y N**
Caregiver reciprocates/responds to **social** bids by the infant (affect/emotion/smile?)**Y N**
Caregiver gross/global level of verbal responsiveness or reciprocation:
High (frequently responds to infant bids) ___
Occasional ___
Rarely/Almost Never ___
Never ___

Mealtime Communication "Red Flags" Severity Rating Scale

		Yes	+1	No
1	Infant **looks** at caregiver's face at least once during feeding	y		n
2	Infant **engages** caregiver **during feeding**: **smiles** at caregiver_____ **vocalizes** for attention______ Other:	y		n
3	Infant **responds** to caregiver during feeding: Smiles back___ vocalizes in response____ turns in response to name____ Other:	y		n
4	**Vocalizes** at all during observed **feeding footage** (**non-crying** soft, throaty, gurgling sounds, raspberries, CV or CVCV) Describe:	y		n
5	Infant attempts to **imitate** a sound, word, or gesture **while feeding** Describe/list:	y		n
6	**Infant Gestures** (non-verbal act) during observed **feeding footage** e.g. request or protest by: reaches___ pulls___ pushes away___ shakes head____ Other describe/list:	y		n
	Total (one point for every shaded/no answer)			

Caregiver talks to and/or gestures to the infant during feeding? **Y** **N**

Caregiver is responsive to infant signals during feeding (stop/start/change position) **Y** **N**
Caregiver reciprocates/responds to **social** bids by the infant (affect/emotion/smile?)**Y** **N**

Caregiver gross/global level of responsiveness or reciprocation during feeding:
High (frequently responds to feeding cues) ___
Occasional ___
Rarely/Almost Never ___
Never ___

**Oral-Motor Feeding Dysfunction Severity Rating Scale:
Bottle Feeding**

		Yes	No	N/A
1	Anticipatory mouth opening most of the time	y	n	
2	Panic reactions, examples could include: eyes widening, increase of tension, gag, arching, pushing away frequently, "stop" with hand, crying after an audible swallow	y	n	
3	Able to settle onto nipple and/or initiate sucking once in mouth	y	n	
4	Seal Observed: no liquid loss **and/or** nipple not easily pull out	y	n	
5	More than intermittent liquid loss throughout feeding (>50% time)	y	n	
6	Continuous or repeated Audible suck/click/swallows	y	n	
7	Smooth, rhythmic sequence to sucking	y	n	
8	Sustained sucking (4+ sucks) without frequent sucking pauses	y	n	
9	Infant observed to be working hard to breathe during feeding	y	n	
10	Cough, choke, or gag observed during observation period (1x)	y	n	
11	Multiple cough, choke, or gag during observational period	y	n	
12	Munch or chew of nipple observed at start or middle of feeding	y	n	
	Total= total # of dysfunctional (shaded) skills noted **Total**			

N/A= not able to observe at this time

Positioning and Support:
Describe:

Food:

Tools:

Oral-Motor Feeding Dysfunction Severity Rating Scale:
Spoon Feeding

		Yes	No	N/A
1	Anticipatory mouth opening most of the time	y	n	
2	Panic reactions, examples could include: eyes widening, increase of tension, gag, arching, pushing away frequently, “stop” with hand, crying after an audible swallow	y	n	
3	Lips are active: closure of upper and/or lower lips on spoon	y	n	
4	More than intermittent food loss throughout feeding (>50% time)	y	n	
5	Audible suck/click/swallows *(> 50% of time?)*	y	n	
6	Smooth, rhythmic sequence >3 suck, swallow, munch, chew seen	y	n	
7	Infant observed to be working hard to breathe during feeding	y	n	
8	Cough, choke, or gag observed during observation period (1x)	y	n	
9	Multiple cough, choke, or gag during observational period	y	n	
10	Consistent/considerable protrusion of tongue (>50% of time)	y	n	
11	Suckle pattern instead of munch pattern observed in chewing	y	n	
	Total= total # of dysfunctional (shaded) skills noted **Total**			

N/A= not able to observe at this time

<u>Positioning and Support:</u>
Describe:

Food(s):
Tools:

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